Hawaii Geothermal Review and Industry Update for Government Leaders and Staff

Kalanimoku Building, 1151 Punchbowl Street
Conference Room 322
January 7, 2004

Purposes:

- *To facilitate understanding of Hawaii's geothermal resource, its development and management;*
- *To provide updates on the local and national geothermal industry;*
- *To introduce the U. S. Department of Energy's (DOE) GeoPowering the West (GPW) program.*

Sponsor: *DOE*
Organizers: *Department of Business, Economic Development & Tourism (DBEDT), Department of Land and Natural Resources (DLNR), DOE, National Renewable Energy Lab (NREL), Sandia National Labs (SNL).*

AGENDA

8:30 am	**Welcome and Introductory Remarks**	Eileen Yoshinaka Peter Young Maurice Kaya	Pacific Liaison, DOE Director, DLNR Chief Technology Officer, DBEDT
8:45am	**Regional Perspectives on Geothermal Development**	Curtis Framel	Prog Mgr, DOE/ Seattle Regional Office
	GPW and Geothermal Program Overview	Susan Norwood	GPW National Coordinator, DOE
9:00 am	**Direct Use Applications**	John Lund	Director, Geo-Heat Center
9:15 am	**Power Generation Overview**	Roger Hill	GPW Technical Director, SNL
9:30 am	**Break**		
9:45 am	**PANEL: The Hawaii Experience** *(Moderator: Framel)*		
	° Hawaii's Resource Assessment Program	Donald Thomas	Director, Center for the Study of Active Volcanoes, UH
	° Puna Geothermal Venture Update	Barry Mizuno	Owner's Representative, PGV
	° Direct Use in Hawaii	Andrea Gill	Energy Conservation Analyst, DBEDT
	° Cultural Overview	Davianna McGregor	Faculty, Coll. of Social Sciences, UH
10:45 am	**Break**		
11:00 am	**PANEL: Management in Hawaii** *(Moderator: Kaya)*		
	° Renewable Energy Goals	Maurice Kaya	Chief Technology Officer, DBEDT
	° DLNR's Geothermal Program	Eric Hirano	Engineering Division, DLNR
	° DOH's Monitoring Program	Chauncey Hew Wilfred Nagamine	Environmental Management Division, Dept. of Health
	° County of Hawaii		County of Hawaii
12:00	**Lunch**		
1:00 pm	**PANEL: National Overview** *(Moderator: Framel)*		
	° U.S. Electrical Generation Projects & Assessments	James Lovekin	Mgr of Field Operations, GeothermEx, Inc.
	° National Lab Programs	Gerald Nix	Geothermal Energy Prog Mgr, NREL
	° Geothermal to Hydrogen	Jonathan Hurwitch	Sr. Vice-President, Sentech, Inc.
2:15 pm	**Break**		
2:30 pm	**PANEL: Viewpoints – Present and Future – Partnership** *(Moderator: TBA)*		
	° Legislative Perspective	Rep. Hermina Morita	Chair, House Energy & Environ. Protection
	° Energy Stakeholder Perspective: Hawaii Policy Strategies	Michael Hamnett	Dir., Social Science Research Institute, UH
	° Utility Perspective	Warren Lee	President, HELCO
	° Industry Perspective	Mike Kaleikini	Plant Manager, PGV
	° Discussion	All	
4:00 pm	**Close**	Curtis Framel	DOE

1/7/04 Attendees

C:\WINNT\Profiles\cyimalk\LOCALS~1\Temp\d.Lotus.Notes.Data\GPW_nametags.doc

Speaker

Tino	Satele	American Samoa Energy Office
Joachim	Fong	American Samoa Power Authority
Jeff	Shively	American Samoa Power Authority
Monte	Morrison	Constellation Geothermal
Ray	Carr	County of Hawaii
Chris	Yuen	County of Hawaii
Kal	Kobayashi	County of Maui
Steve	Alber	DBEDT
Shon	Carilyn	DBEDT
✓ Andrea	Gill	DBEDT
✓ Maurice	Kaya	DBEDT
Priscilla	Thompson	DBEDT
John	Corbin	Department of Agriculture
✓ Chauncey	Hew	Department of Health
✓ Wilfred	Nagamine	Department of Health
Bill	Wong	Department of Health
✓ Eric	Hirano	DLNR
(Sub for Peter) ✓ Ernest	Lau	DLNR
Andrew	Monden	DLNR
Eric	Tanaka	DLNR
Nami	Wong	DLNR
Alyson	Yim	DLNR
Peter	Young	DLNR
✓ John	Lund	Geo-Heat Center
✓ James	Lovekin	GeothermEx, Inc.
Darren	Ishimura	Hawaiian Electric Company
Art	Seki	Hawaiian Electric Company
✓ Warren	Lee	HELCO
Bob	Neilson	Idaho National Engineering and Environmental Lab
✓ Gerald	Nix	National Renewable Energy Lab
Jacqui	Hoover	NELHA
Mike	Kitamura	Office of Congressman Akaka
Jim	Nakatani	Office of Congressman Case
Carlito	Caliboso	Public Utilities Commission
Lisa	Kikuta	Public Utilities Commission
Janice	Masuda	Public Utilities Commission
Brooke	Nagaji	Public Utilities Commission
Richard	VanDrunen	Public Utilities Commission

Mike	Kaleikini	Puna Geothermal Venture
Barry	Mizuno	Puna Geothermal Venture
Roger	Hill	Sandia National Labs
Jonathan	Hurwitch	Sentech, Inc.
Greg	Champneys	Soda Lake Geothermal Facility
Rep. Hermina	Morita	State House of Representatives
Morris	Atta	State Senate Majority
Curtis	Framel	U.S. Department of Energy
Susan	Norwood	U.S. Department of Energy
Michelle	Rathbun	U.S. Department of Energy
Eileen	Yoshinaka	U.S. Department of Energy
Davianna	McGregor	UH College of Social Sciences
Michael	Hamnett	UH Social Science Research Institute
Pat	Cooper	UH SOEST
Donald	Thomas	UH SOEST
Steve	Chapman	USDA Rural Development
Lorraine	Shin	USDA Rural Development

DRAFT

Hawaii Geothermal Review and Industry Update
for Government Leaders and Staff
January 7, 2004

Welcome and Introductory Remarks – Peter Young (8:30 am)

Welcome and thank you for coming to the Hawaii Geothermal Review and Industry Update.

Thank you to the U.S. Department of Energy for sponsoring this information exchange that I'm sure all of us will find enlightening. The presentations by the various speakers will show a multitude of perspectives that must work together toward the common goal of responsible development and management of our geothermal resources.

Priscilla Thompson@DBEDT
01/06/2004 11:11 AM

To: Alyson K Yim/DLNR/StateHiUS@StateHiUS
cc:
Subject: MHK's comments and ppt

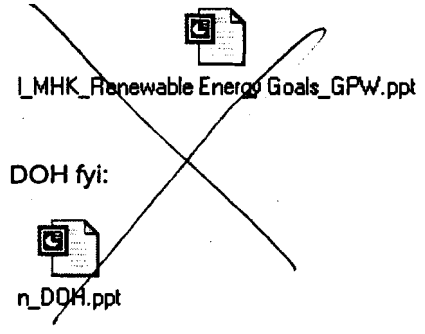
WELCOME AND INTRODUCTORY REMARKS .. Maurice Kaya (1/7/04 8:30am)

I'd like to extend my appreciation to those of you in attendance at this workshop. The subject of geothermal is important to all the people of Hawaii, and we appreciate the effort that you have made to be here.

Today's meeting, sponsored by the U.S. Dept. of Energy's GeoPowering the West program, offers us an opportunity to focus on current and potential uses of Hawaii's geothermal resources. You will hear presentations on a broad range of topics intended to increase our understanding of geothermal, and the benefits and challenges that accompany the use of the resource.

As you will hear shortly from Curtis Framel, the DOE's GeoPowering the West program works with states to address issues in support of increased use of geothermal resources for power generation or other purposes. Education is the primary objective of the workshop, however, the DOE is also here to listen and to find out whether there is a desire within Hawaii to start and to continue working together with the support of the program.

We thank Director Young and his staff at DLNR for their partnership in this effort. And we are grateful to the U.S. Dept. of Energy for its continuing assistance to Hawaii's energy efficiency and renewable energy programs.



Priscilla C. Thompson
Dept. of Business, Economic Development & Tourism
Strategic Industries Division
235 S. Beretania St., 5th Floor, Honolulu, HI 96813

Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804
Phone: (808) 586-2353 Fax: (808) 586-2536

www.hawaii.gov/dbedt/ert/

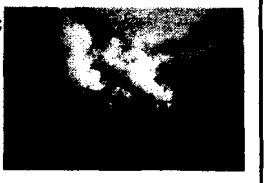
GeoPowering the West

Susan Norwood
GeoPowering the West
National Coordinator
U.S. Department of Energy

January 7, 2004
Hawaii Geothermal Meeting
Honolulu, Hawaii

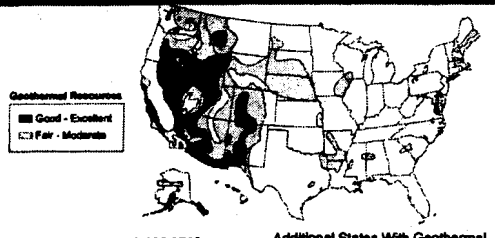
Geothermal Energy Challenges

- Appropriate Use of Public Lands
- Consistent & Supportive Policies
- Transmission Access
- Public Awareness



- Cost of Electricity
- Resource Exploration
- New Technologies

Geothermal Resource Map



U.S. Installed Capacity (2,800 MW)
- California – 2500 MW
- Nevada – 200 MW
- Utah – 40 MW
- Hawaii – 30 MW

Additional States With Geothermal Development Potential:
-Alaska -Idaho
-Arizona -New Mexico
-Colorado -Oregon
-Wyoming

The Geothermal Technologies Program

Mission: To work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply.

- Energy
  - Balance national energy portfolio
- Economics
  - Capture domestic and international markets
- Environment
  - Limit impacts of power production

Research Priorities

- **Resource Assessment and Exploration Technology**
- **Advanced Drilling Technology**
- **Enhanced Geothermal Systems**

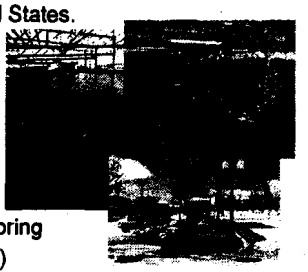
What is GeoPowering the West?

- An outreach effort with state and local emphasis to increase the use of geothermal energy across the West
- Activities that focus on institutional and other non-technical barriers to geothermal development
- A complement to the R&D activities of the DOE Geothermal Technologies Program
- A collaboration of stakeholders that supports a vision for dramatically expanded use of geothermal energy

Direct Use Applications

Direct use displaces about 1.6M barrels of oil annually in the United States.

- District Heating
- Process Heat
- Agriculture
- Aquaculture
- Balneology (hot spring and water bathing)



The GPW Network

Department of Energy

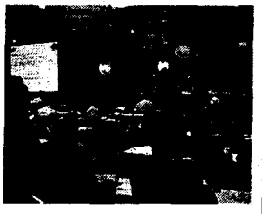
- Geothermal Technologies Program
- Lead National Laboratories
- EERE Seattle and Denver Regional Offices
- Power Marketing Administrations

Our Collaborators

- State Energy/Resource Programs
- Other Federal Agencies
- Industry/Trade Association
- Tribal Organizations
- Universities
- Non-Profit Organizations

State Working Groups

- Provide state-wide coordination and outreach
- Co-sponsor workshops
- Identify key barriers/opportunities
- Outreach to local communities
- Leverage resources
- Provide information



Farm Bill - Title IX Section 9006

- Renewable Energy Systems & Energy Efficiency Improvements
  - 5 year, $23M/yr for Renewable and Energy Efficiency Projects
  - 50% for RE and 50% EE
  - Wind, solar, biomass, geothermal, hydrogen, building and industrial efficiency
  - Farmers, Ranchers, Rural Businesses
  - 25% Grant Program, $100 M in total project value
  - Non-R&D (Bricks and Mortar)
  - Interagency Effort (USDA Lead, DOE & EPA Support)

FY04 Total Project Value over $400 Million (loans and grants)

Farm Bill - Title IX Section 9006

- California - $691,830
- Illinois - $2,186,596
- Massachusetts - $970,000
- Mississippi - $231,503
- Nebraska - $177,654
- North Dakota - $10,410
- South Dakota - $62,500
- Virginia - $ 500,000
- Hawaii - $60,966
- Iowa - $1,258,440
- Michigan - $434,500
- Missouri - $124,499
- New York - $2,878,027
- Ohio - $2,043,612
- Texas - $999,350
- Washington - $883,028
- Idaho - $1,010,000
- Kansas - $29,075
- Minnesota - $4,678,632
- Montana - $37,000
- North Carolina - $130,000
- South Carolina - $15,000
- Vermont - $79,001
- Wisconsin - $1,715,610

USDA/Rural Development

WASHINGTON, D.C. 20250-0705

USDA Farm Bill Section 9006 Update
Thursday, November 6, 2003

On April 8, 2003, the U.S. Department of Agriculture (USDA) announced the availability of $23 million in funds for fiscal year 2003 to assist farmers, ranchers, and rural businesses to purchase renewable energy systems and make energy efficiency improvements. The funds are the result of Section 9006 of the 2002 Farm Bill, which provided $23 million in FY 2003 for wind, solar, biomass, geothermal, hydrogen from renewables, and energy efficiency projects.

Who is eligible for the funding?
An agricultural producer or rural small business that owns and controls the operation may be eligible for funding. The funding request must not exceed 25% of the eligible project costs for grant requests and must not exceed 50% for combinations of grants and loans. Grant funding requires that the applicant demonstrate financial need. The funds cannot be used for research, development, land acquisition, or crop production.

What types of projects are eligible for funding?
Eligible projects include systems that generate energy from wind, solar, biomass, or geothermal source or that produce hydrogen derived from biomass or water using a renewable energy source. Eligible projects also include energy efficiency improvement projects. In 2003, a total of $21.7 million in grant money was distributed to 114 projects in 24 states.

How can I apply?

For fiscal year 2004, a Federal regulation is being promulgated that outlines how the USDA will adhere to the requirements of Section 9006. This proposed regulation will be released in the Fall of 2003 and will be available for public comment for 60 days. The proposed regulation will cover grant, loan, and loan guarantee requirements. The respective amount of funds to be apportioned to grants, loans, and loan guarantees are to be determined.

All parties interested in pursuing the funding opportunities available under the Renewable Energy Systems and Energy Efficiency Improvements Programs should work with rural energy coordinators at the respective USDA State Rural Development Offices to prepare and submit applications once the final rule is published and funds are available.

Interested parties should also contact these rural energy coordinators to learn when the proposed regulation will be made available for public comment and when funds will be available for FY 04. A list of these rural energy coordinators can be found by visiting http://www.rurdev.usda.gov/rbs/farmbill/contacts.htm. Further information can also be found at http://www.rurdev.usda.gov/rbs/farmbill/resourc.htm.

#

Summary of Farm Bill Section 9006 Program

Farm Bill – Title IX Section 9006

- Renewable Energy Systems & Energy Efficiency Improvements
  - 5 year, $23M/yr for Renewable and Energy Efficiency Projects
  - 50% for RE and 50% EE
  - Wind, solar, biomass, geothermal, hydrogen, building and industrial efficiency
  - Farmers, Ranchers, Rural Businesses
  - 25% Grant Program
  - Non-R&D (Bricks and Mortar)
  - Interagency Effort (USDA Lead, DOE & EPA Support

FY04 Total Project Value over $400 Million (loans and grants)

Farm Bill – Title IX Section 9006 – PROCESS LAST YEAR

- Implemented via Notice of Funding Availability
- Opened April 8; Closed June 27 (extension)
- Administered through US DA State Offices
- Technical sections to DOE -Labs for Technical Review
- Tech. Viability Reports to US DA
- Recommendations by USDA/RD Offices
- USDA HQ Funding Determination
- Awards Announced August 25, 2003

Farm Bill – Title IX Section 9006 – DOE SUPPORT

- Wind Program Lead for DOE/EERE
- Development of Notice of Funding Availability (NOFA)
- DOE-Lab Technical Team
  - NREL, SNL, ORNL
- Renewables and Efficiency Technologies Briefings
  - Oklahoma City, April 8-10, 2003
  - Orlando, July 17, 2003
  - EERE Regional Office and NASEO Representation
- Development of Web-Based Info
- DOE Technical Review of Proposals
- Program Measures and Metrics Development
- Cost-shared Technical Staff Support

Farm Bill – Title IX Section 9006

- **147 total applications from 27 states**
- **110 sent to DOE/Labs for Tech. Review**
- **113 funded in 24 states**
- **Total awards of $21.2 M**

Farm Bill – Title IX Section 9006 – PROGRAM COST/BENEFITS

Technology	FY03 Applications Reviewed	FY 03 USDA Awards (millions) Represents less than 25% of total investment in technology specific projects
Biomass	40	$ 9.87
Wind	38	$ 7.39
Buildings EE	8	$ 0.38
Industrial EE	2	$ 1.34
Solar	8	$ 0.73
Geothermal	2	$ 0.40
Hydrogen	1	$ -
Hybrids	6	$ 2.11
TOTAL	110	$ 21.39

Farm Bill – Title IX Section 9006

- California - $691,830
- Illinois - $2,186,596
- Massachusetts - $970,000
- Mississippi - $231,503
- Nebraska - $177,654
- North Dakota - $10,410
- South Dakota - $62,500
- Virginia - $ 500,000
- Hawaii - $60,966
- Iowa - $1,258,440
- Michigan - $434,500
- Missouri - $124,499
- New York - $2,878,027
- Ohio - $2,043,612
- Texas - $999,350
- Washington - $883,028
- Idaho - $1,010,000
- Kansas - $29,075
- Minnesota - $4,678,632
- Montana - $37,000
- North Carolina - $130,000
- South Carolina - $15,000
- Vermont - $79,001
- Wisconsin - $1,715,610

Farm Bill – Title IX Section 9006 PROCESS THIS YEAR

- **Development of FY04 Section 9006 Grants and Loan Program**
  - Draft of the Rules (Dec – Jan 047)
  - Publish Rules for public co mment Winter 2004
  - Late Spring early summ er open for applications
  - July thru August – review of applica tions
  - Septem ber announcem ents of successful applicants
- **Improve Quality of Applications**
  - Toolkit for Applicants
    - Models
    - Guide lines
  - Standard Development Process

Farm Bill – Title IX Section 9006 What You Can Do...

Outreach & Technical Assistance:

- Get the word out to potential applicants on this potential source of project funding
  - Add as element of meetings, workshops, websites
  - Secure USDA state-level representation/participation (see state contacts via http://www.rurdev.usda.gov/rd_map.html
- Support development of more & better applications
  - Link to USDA Sec. 9006 technical info websites
  - http://www.rurdev.usda.gov/rbs/farmbill/resourc.htm
- Use stakeholder and industry networks to support effort
  - Share draft Rulemaking, timelines, etc., when available (expected Winter 2004)
  - Will be posted at http://www.rurdev.usda.gov/rd/farmbill/9006resources.html
- More to follow soon...

GEO
GEOTHERMAL EDUCATION OFFICE

http://geothermal.marin.org

GEOTHERMAL ENERGY USES

Temperatures at which geothermal resources are typically used...

700°F

400°F
204°C
350°F

Flash & Dry Steam Geothermal Power Plants

177°C
300°F

Binary Geothermal Power Plants

149°C
250°F

121°C
200°F

95°C
150°F

66°C
100°F

38°C
70°F

60°F

50°F

40°F/10°C

Beet Sugar Evaporation

Pulp & Paper Processing

Lumber Drying

Cement Curing

Fabric Dyeing

Building & Water Heating

Blanching Cooking, & Pasteurization

Biogas Process

Fruit & Vegetable Drying

Mushroom Culture

Soft Drink Carbonation

Food Processing

Greenhousing

Aqua-culture*

Bathing

Soil Warming

Geothermal Heat Pumps

*Cool water is added when needed to make the temperature just right for various types of fish.

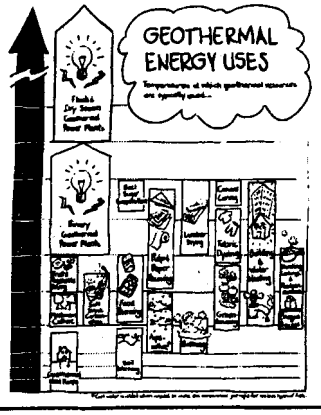
DIRECT HEAT UTILIZATION OF GEOTHERMAL ENERGY

John W. Lund

Director
Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, Oregon, USA

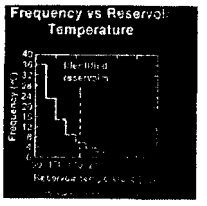
What is Direct-Use: Heating and Cooling

- Swimming, bathing and balneology
- Space heating and cooling
  - Including district energy systems
- Agriculture applications
  - Greenhouse heating
- Aquaculture applications
  - Fish pond and raceway heating
- Industrial processes
  - Including food and grain drying
- Geothermal heat pumps



Advantages of Direct-Use of Geothermal Energy

- Can use low- to intermediate temperature resources (<300°F)
- These resources are more widespread
- Direct heat use (no conversion – high efficiency)
- Use conventional water-well drilling equipment
- Use conventional, off-the-shelf equipment
- Minimum start-up-time

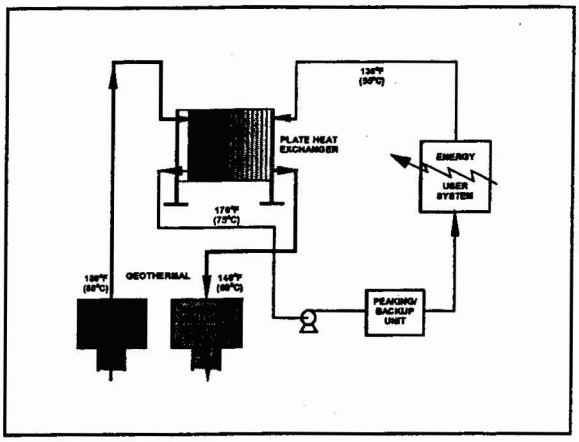


Advantages of Direct-Use of Geothermal Energy

- Can be used on a small scale ("mom and pop operation")
  - Individual home
  - Single greenhouse
  - Single aquaculture pond
- Can also be large scale operation
  - District heating
  - Food and mineral ore drying

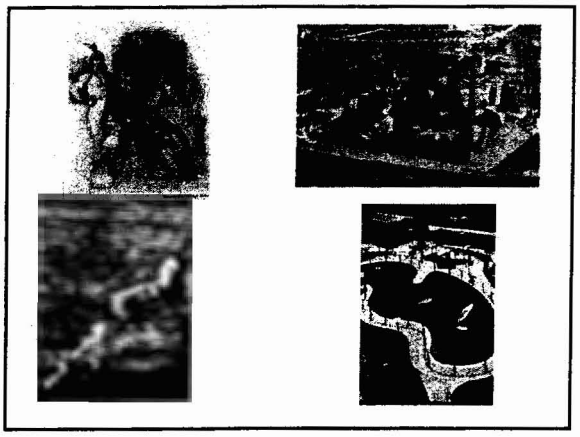
Equipment

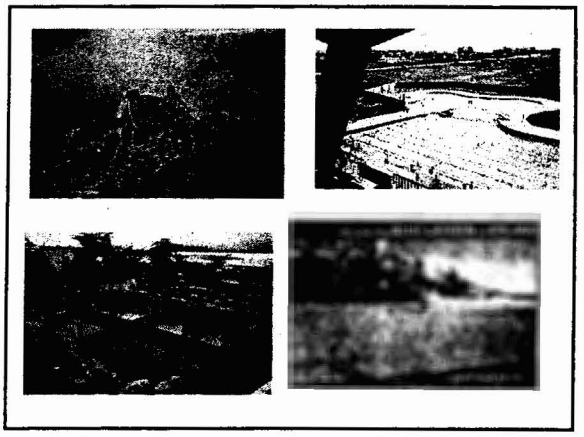
- Often necessary to isolate geothermal fluid to prevent corrosion or scaling
- Care taken to prevent oxygen from entering system
- Dissolved gases and minerals (boron, arsenic, hydrogen sulfide, etc.) may be harmful to plants and animals



Swimming, Bathing and Balneology

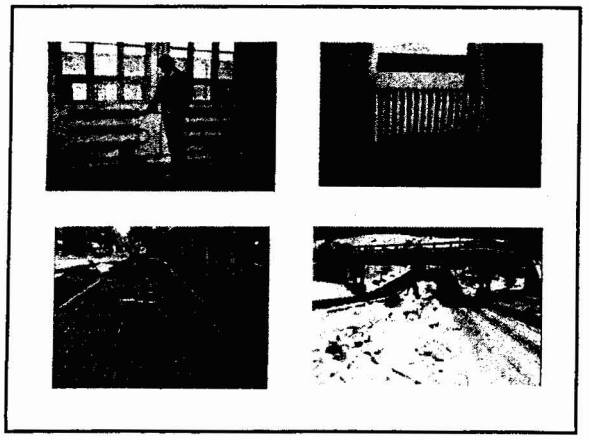
- Main Users (past and present)
  - Romans
  - Chinese
  - Ottomans (Turks)
  - Japanese
  - Central Europeans
  - American Indians (Mexico and USA regions)
  - Spa, Belgium





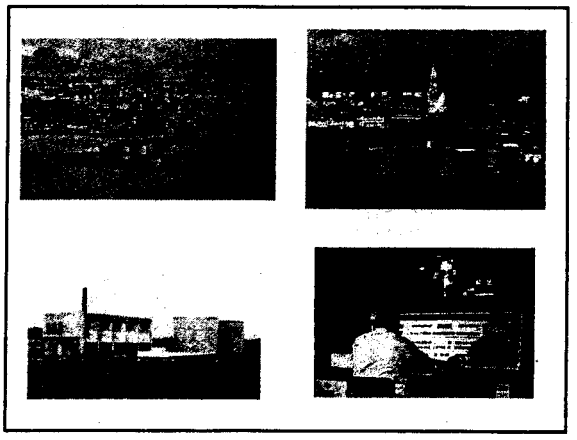
Space Conditioning

- Individual well for a building or several buildings using pumps or downhole heat exchangers connected to room convectors
- Klamath Falls, Oregon (also snow melting)
- Reno, Nevada
- Rotorua, New Zealand
- Taupo, New Zealand
- Several Places in Turkey



District Heating – Examples

- 18 locations in the US – total 100 MWt
- Reykjavik, Iceland – started 1930
- 190,000 people (99.9% of city)
- 190° to 260°F water – supplied at 175°F
- Adequate to –15°F – oil fired booster station
- 62 wells providing 830 MWt
- Large storage tanks for peaking

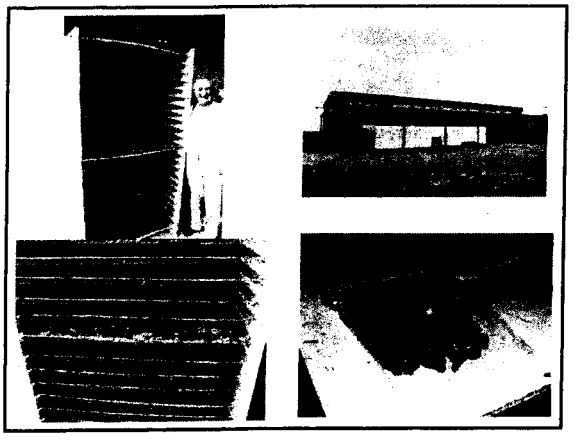


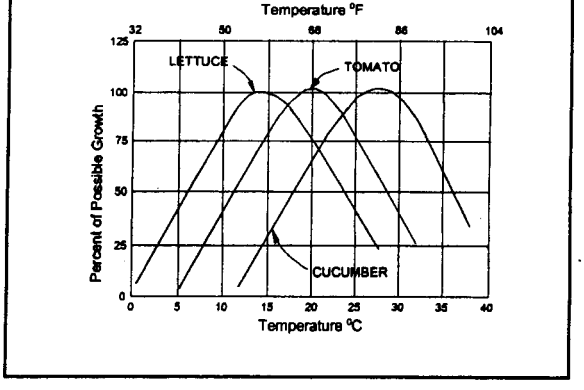
Agribusiness Applications (1)

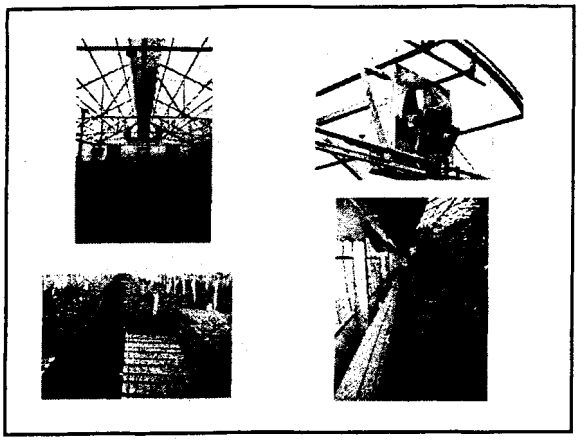
- Greenhouse heating (flowers, vegetables, tree seedlings)
  - 5 to 35% savings in heating costs
- Animal pen heating and cleaning
- Soil warming
- Crop irrigation
- Mushroom raising
- Soil and mulch sterilization
- Aquaculture
  - 50% increase in growth rate
  - Catfish, shrimp, tilapia, eels, tropical fish

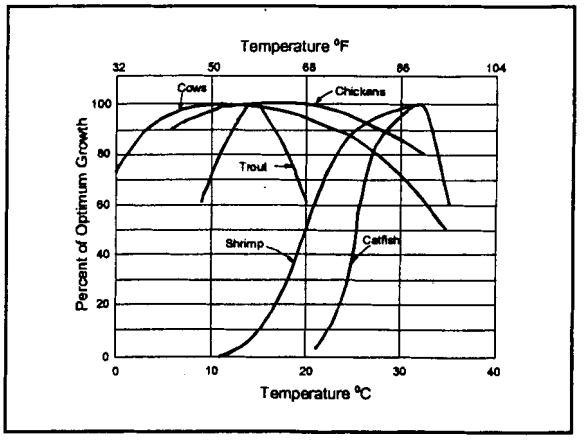
Agribusiness Applications (2)

- Must consider heavy metals, fluorides, chlorides, arsenic and boron in fluid
- Can produce CO_2 for greenhouses to improve growth
  - Iceland, New Zealand
- Wairakei, New Zealand
  - Malaysian prawns, alfalfa drying (pellets)
- Klamath Falls, OR
  - Tree seedlings, tropical fish





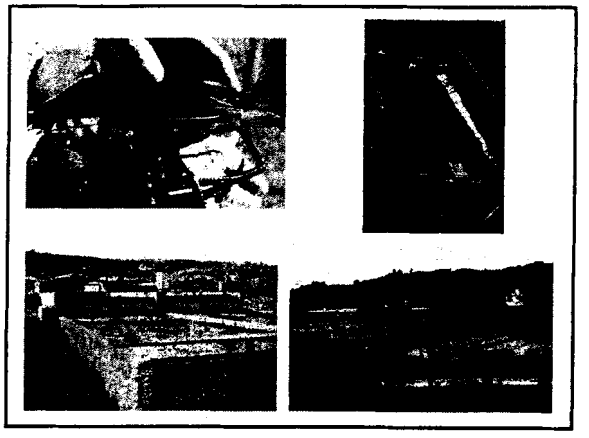




Aquaculture – Example

Wairakei, New Zealand – freshwater prawns

- 19 ponds – 0.5 to 0.9 acre – 3 to 4 ft. deep
- 75°F – effluent from power plant
- Produces 30 tons/yr
- Harvested after 9 months at 14 to 18 tails/lb
- Sold for US$17/lb wholesale and US$27/lb retail
- 90% sold to restaurant on the property
- 25,000 tourists/yr
- Future expansion to 100 acres and will produce 400 tons/yr – income of US$ 6.7 million

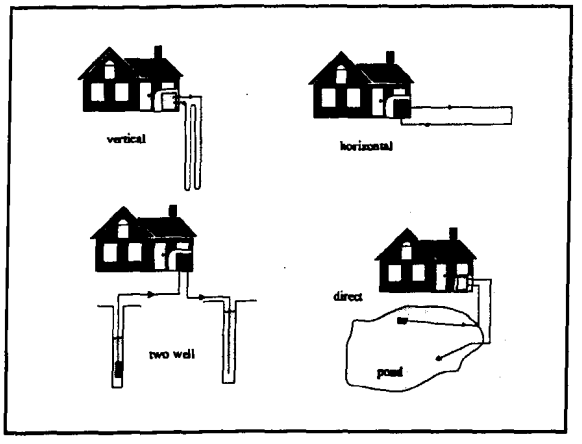


Refrigeration

- Lithium bromide system (most common – uses water as the refrigerant)
  - Supplies chilled water for space and process cooling – above the freezing point
  - The higher temperature, the more efficient (can use geothermal fluids below 200°F – however, >240°F better for 100% efficiency)
- Ammonia absorption used for refrigeration below freezing normally large capacity and require geothermal temperatures above 250°F

Heat Pumps (1)

- Ground source or geothermal heat pumps (GSHP or GHP) – uses 40 to 90°F ground temperature
- 50 to 100% more efficient than air source, since uses constant temperature resource
- Ground coupled
  - Horizontal in trenches 3 – 10 ft deep
  - Vertical in 4-inch diameter 150 – 200 ft. deep drillholes
  - Others
- Ground water
  - Using well water

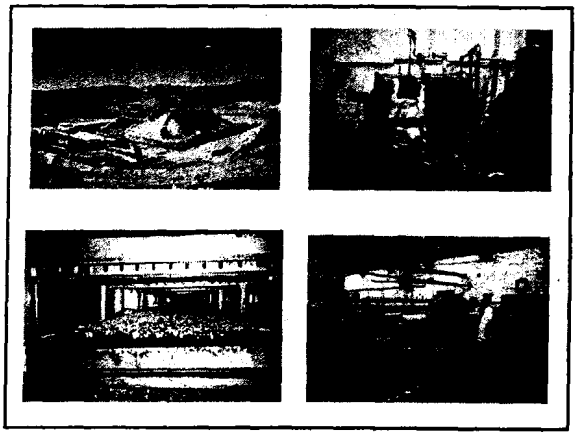


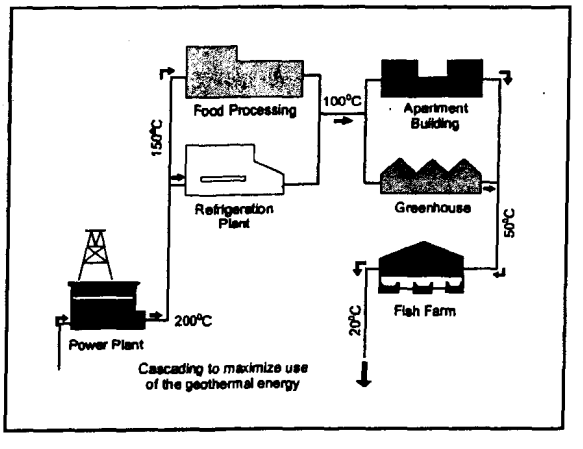
Heat Pumps (2)

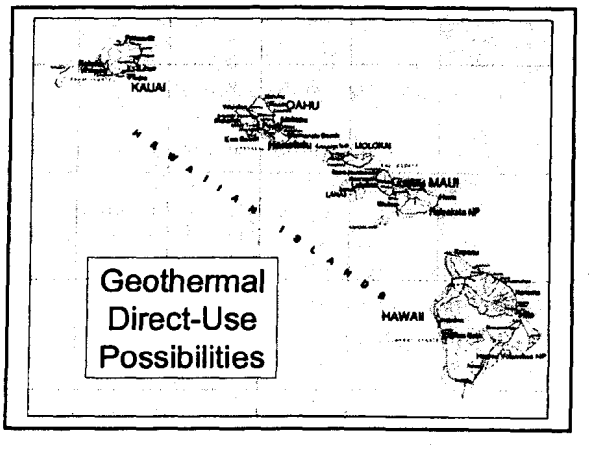
- Used for both heating and cooling
- Heated capacity of 3 kW to 1,500 kW
  - 1 ton to 500 tons (of cooling capacity)
- Solar vs geothermal heating????
- 27 countries – US the leader
- >500,000 units installed in US
- COP of 4

Industrial Applications

- Oldest: Larderello, Italy – boric acid and borate compounds processed since 1790
- New Zealand: pulp, paper and wood processing at Kawerau
- Iceland: diatomaceous earth drying – Myvatn
  - Fish drying and salt production
- USA: vegetable dehydration (onion) – Nevada
  gold extraction (heap leaching) - Nevada







HAWAII (1)

- Little need for space heating and cooling – except for large buildings (cooling)
- High temperature resource on Big Island
- Low-to-moderate temp. resource on Maui
- Possible resource on Molokai and Oahu

HAWAII (2)

- Possible uses of geothermal on Hawaii
  - aquaculture pond heating
  - greenhouse heating
  - crop/timber drying
  - refrigeration
  - heat pumps for cooling of resorts, public and commercial buildings
  - spa and resort pools

HAWAII (3)

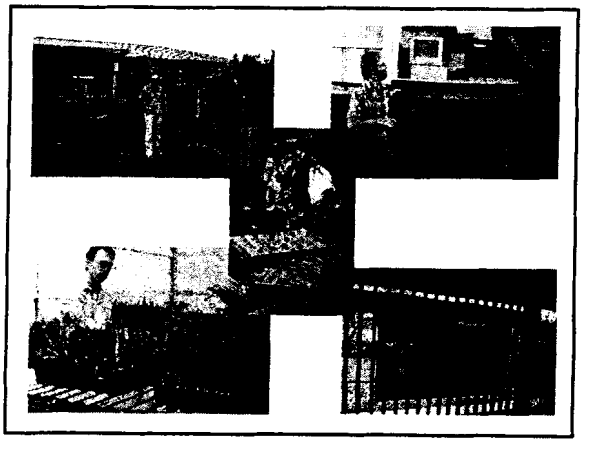
- Aquaculture pond heating
  - constant 80°F temperature needed for optimum growth of many species
  - 100°F minimum temperature needed
  - A 10°F temperature variation = 70% growth rate
- Greenhouse heating
  - Cooling needed during day, heating at night
  - 120°F minimum needed for heating, 200°F for cooling

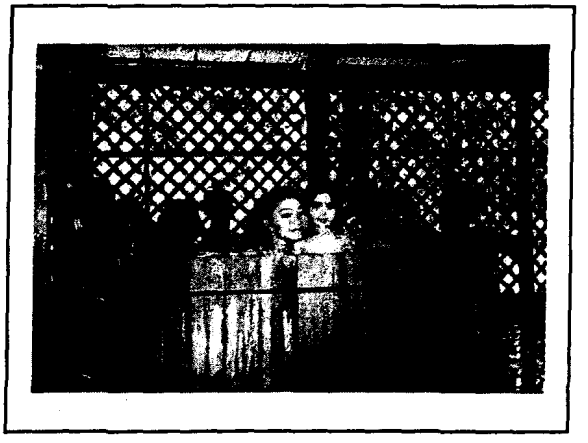
HAWAII (4)

- Crop/timber drying
  - Mainly food dehydration (pineapples and coffee) and hard wood drying (koa)
  - Need 200°F and above
- Refrigeration
  - Cooling – need 200°F and above
  - Refrigeration – need 250°F and above
  - For cold storage (fish)

HAWAII (5)

- Geothermal (ground-source) heat pumps
  - Anywhere in Hawaii
  - Need 40°F to 90°F ground or water temperature
  - Design for cooling load of larger buildings
  - Saving 25 to 75% of electricity load
- Spa and resort pools
  - 70°F to 110°F mineral water desired
  - Rest and relaxation – health and well-being





GeoPowering the West

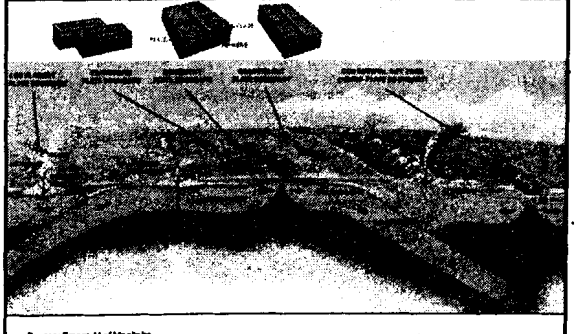
Hawaii Geothermal Review and Industry Update

Roger Hill
Sandia National Laboratories
rrhill@sandia.gov, 505-844-6111
Honolulu, January 7, 2004

Active Volcanoes, Plate Tectonics, and the "Ring of Fire"

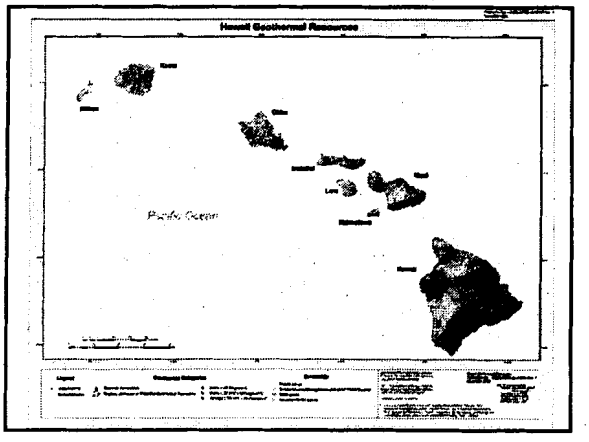
Source: Fraser, U of Manitoba

Geologic Illustrations

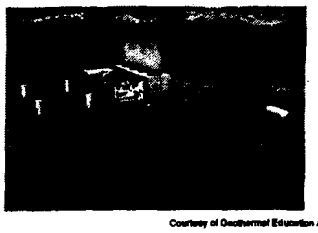


Source: Fraser, U of Manitoba

Hawaii Geothermal Resources



Geothermal Applications



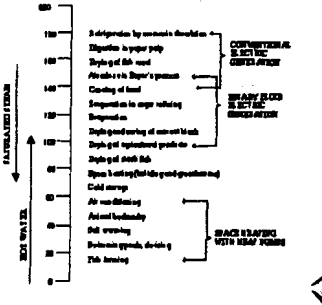
Courtesy of Geothermal Education Association

Electricity Generation
- Central Station Power
- Distributed Power

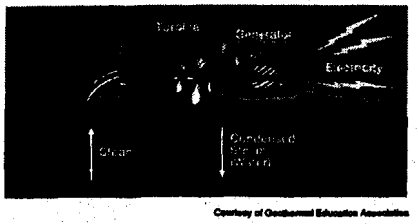
Mineral Recovery
- Zinc
- Silica

Heat Production
- District Heating
- Industrial Process Heat
- Agriculture
- Aquaculture

Lindal Diagram

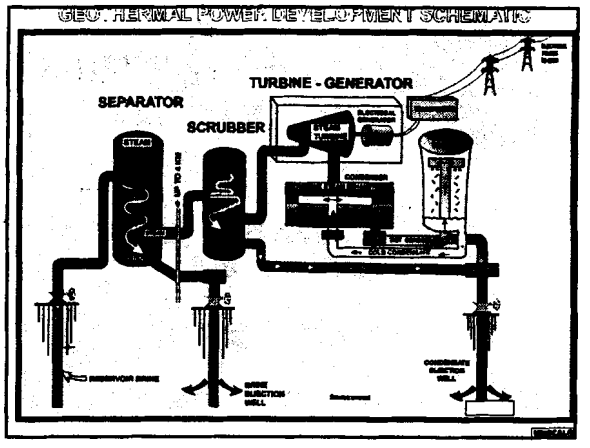


Dry Steam Power Plant



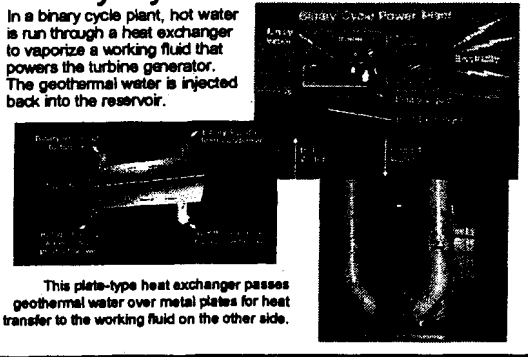
Courtesy of Geothermal Education Association

In dry steam power plants, the steam passes through a rock catcher (not shown) and then directly into the turbine. The steam spins the turbine blades, which spin the generator.



Binary Cycle Geothermal Plant

In a binary cycle plant, hot water is run through a heat exchanger to vaporize a working fluid that powers the turbine generator. The geothermal water is injected back into the reservoir.



This plate-type heat exchanger passes geothermal water over metal plates for heat transfer to the working fluid on the other side.

(EXAMPLE)

DRILLING AND WELL FIELD DEVELOPMENT

Medium risk – Investor Financing Possible

- **Production/injection wells $1.0 to $3.0M each**
- **Production wells provide between 3MW and 30MW**
- **One injection well serves two or more production wells**
- **Well drilling success averages over 70%**
- **3,000 foot average depth – Assume $1.5 M per well**

20 MW Nevada project: 7 prod. & 3 inject. wells

Budget for 10 wells @3,000 feet depth is $15M
Timetable including permitting would be 12 to 18 months

Source: Ormat

(EXAMPLE)

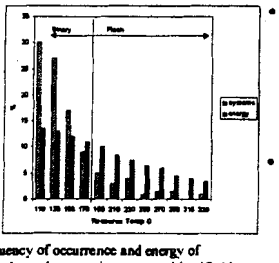
PROJECT DEVELOPMENT BUDGET 20MW
Uses of Funds

Exploration & resource assessment	$ 5.0 M
Well field drilling and development	15.0
Power plant, surface facilities, & transm.	30.0
Financing "soft costs" including:	5.0
o Commitment fees	
o Legal & accounting fees	
o Consultants, and	
o Interest during construction	
o Debt service and operating reserve	

TOTAL *FINANCED* COST FOR 20MW PROJECT $ 55 M
To be provided as construction phase financing

Source: Ormat

Low-Temp Resources are More Common



Frequency of occurrence and energy of hydrothermal convection systems identified by the USGS in 1978

- 83% of the sites require binary plants (also, EGS/HDR will most likely need binary plants)
- And 50% of the available energy is below temperatures requiring binary plants (170C)

Source: NREL

Criteria for Sites Suitable for Geothermal Development

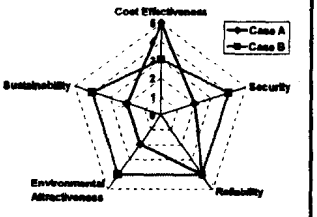
1. Need a good geothermal resource
2. Must have access to loads or grid
3. The land must be developable

But....
Must have a buyer to

Enter the big competition where value = benefits - costs

Expected Trends in Future Energy System Evolution

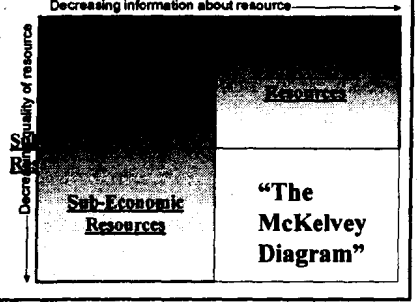
- Energy safety, security, reliability, and sustainability have become important energy system design parameters
- This will change how energy systems are optimized and upgraded
- This will impact future decisions on energy policy, supply, and use
- How do we efficiently and cost-effectively transition to this new future infrastructure?



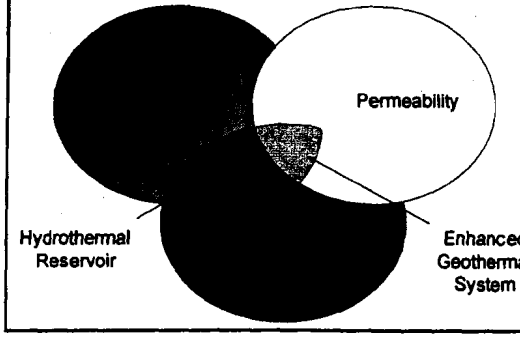
Geologic Assurance and Economic Feasibility

National R&D helps to expand the geothermal resource base:

- ✓Geophysics and geoscience to locate and define reservoirs
- ✓Drilling research to reduce costs
- ✓ Improving capabilities and efficiencies of power plants.



Geothermal Domains



GEOPOWERING THE WEST

Technical Assistance Process

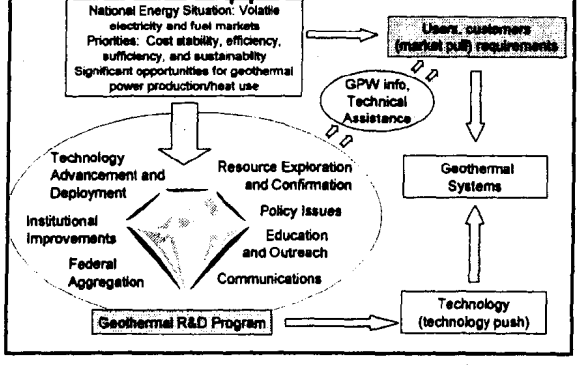
-Relate

Discover-

-Advocate

Support-

GeoPowering the West Approach



A Goal for the Future

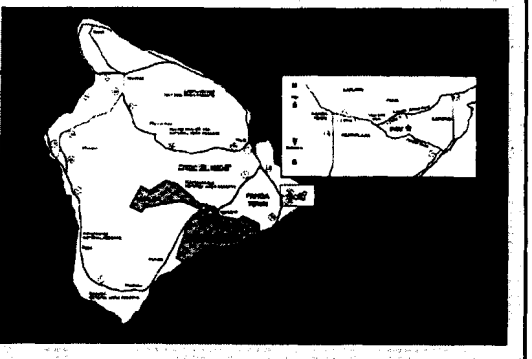
- Appropriate Applications
- Cost Competitive Technologies
- Geothermal as an Enabling Technology

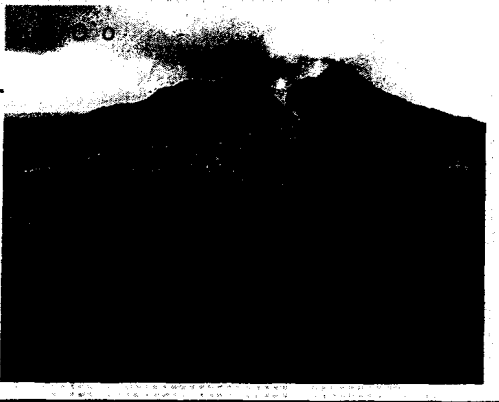
GEOPOWERING THE WEST

PUNA GEOTHERMAL VENTURE

HAWAII

Puna Geothermal Venture Update





Overview:

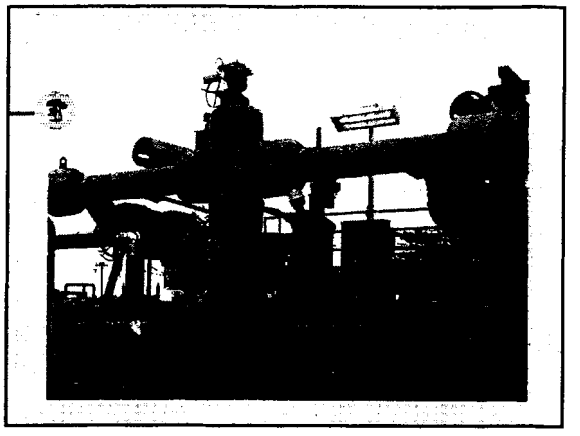
- Puna Geothermal Venture is 100% owned by Constellation Power, Inc.
- Commercial operation started in April, 1993 (10¾ years)
- Originally a 25 MW facility, with 5 MW added in 1996
- 27 employed at PGV

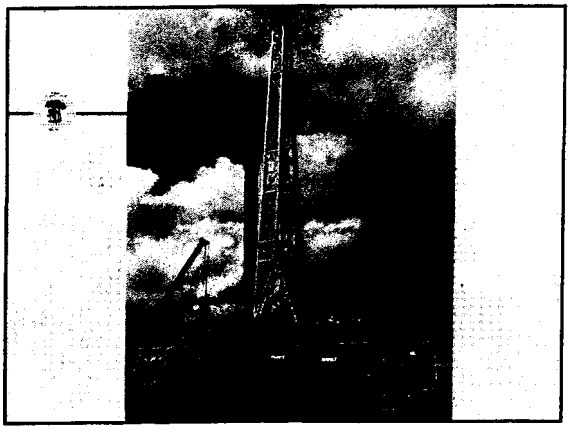
Production Data:

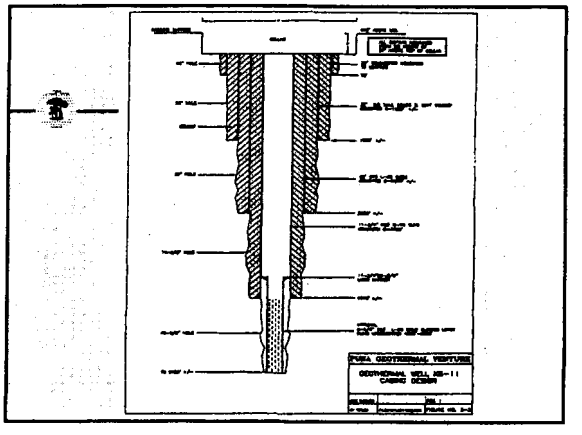
- 7 total operating wells, including 4 injectors and 3 production wells
- 10 identical generating units with 3.5 MW rated capacity each
- Since start-up, electricity export totals 2,100,300 MW
- Equivalent oil displacement of approximately 4,075,000 barrels of oil.
- Currently supplies approximately 20% of the Big Island's electricity
- State Royalties - $4,946,995 as of 12/31/03

Recent Challenges:

- Production well KS-11 completed in December, 1999
- In April, 2002, KS-11 bottom hole casing failed





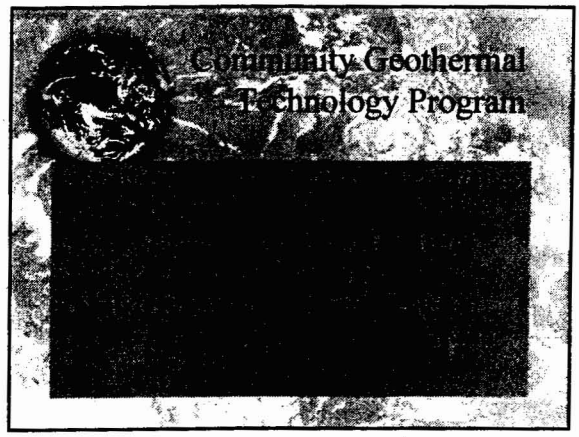


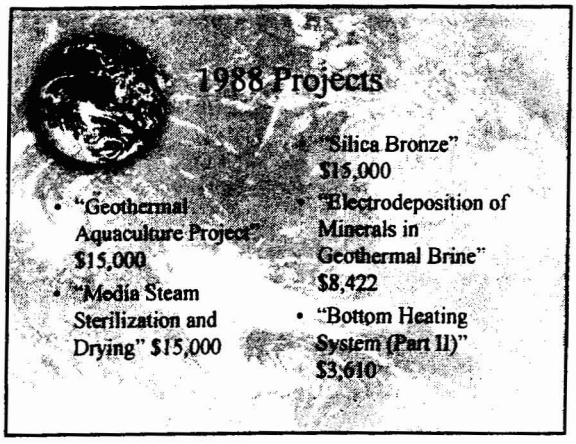
Restoration Effort:

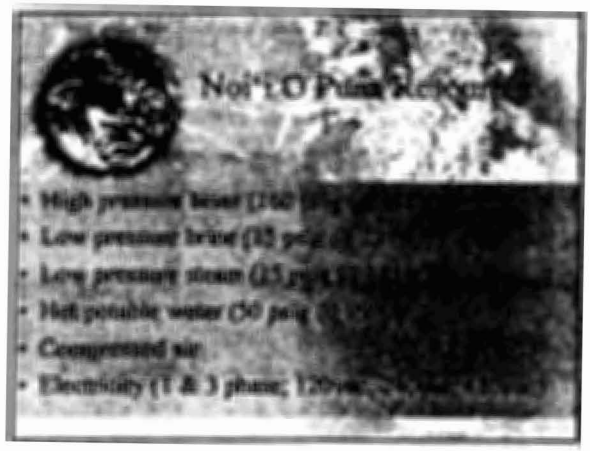
- New production well KS-5 completed in January, 2003
- KS-11 production well was converted into an injection well
- KS-10 production well was cleaned out
- Cost of approximately $20 million

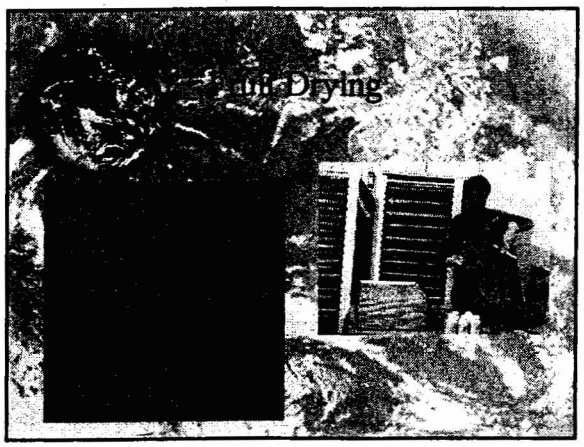
Current Production Status:

- 9 generating units operational, 1 under repair (due back in February)
- Current production averages 27-28 MW, net

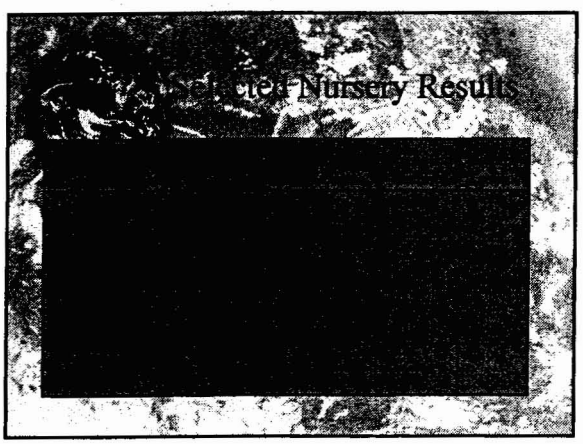

Community Geothermal
Technology Program

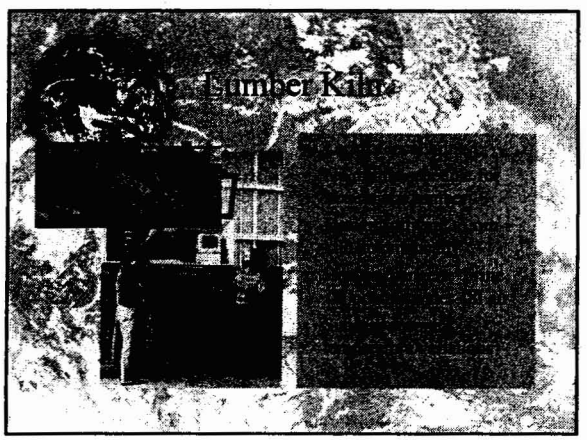

1988 Projects
• "Geothermal Aquaculture Project" $15,000
• "Media Steam Sterilization and Drying" $15,000
• "Silica Bronze" $16,000
• "Electrodeposition of Minerals in Geothermal Brine" $8,422
• "Bottom Heating System (Part II)" $3,610

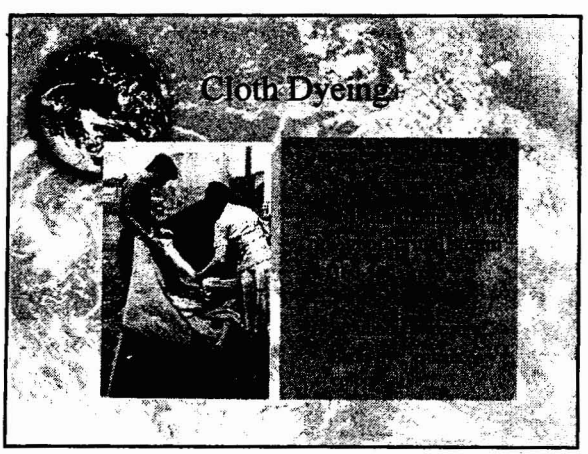


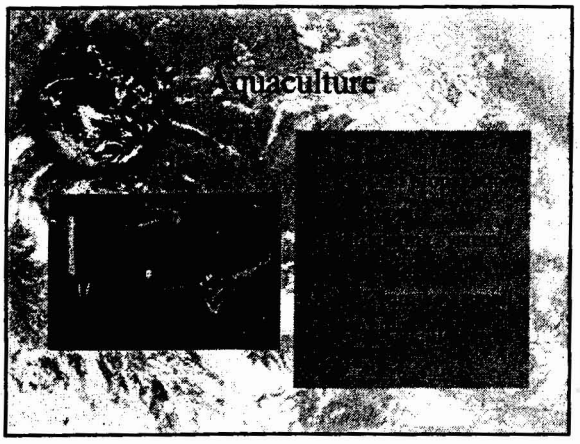


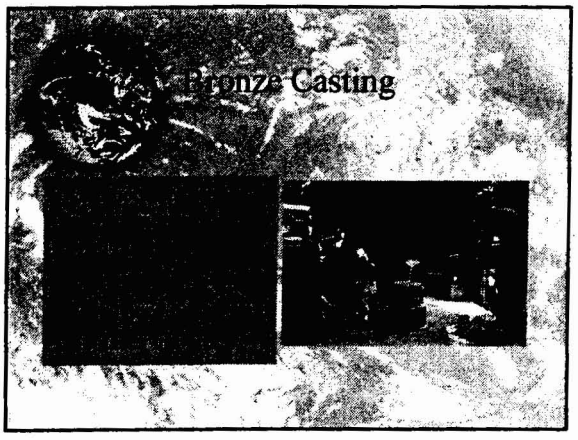

Bottom Heating


Selected Nursery Results


Lumber Kiln


Cloth Dyeing

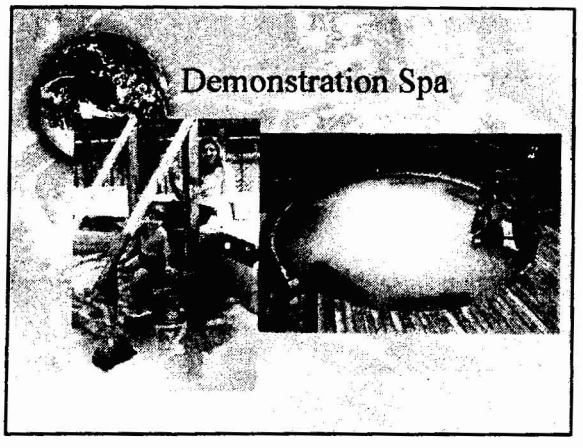




Other Ideas

- Fruit fly disinfestation
- Balneology (spas)
- Refrigeration
- Ice making (commercial fishing)
- Drying of additional agricultural produce

- Proposed "Mini-Park"
  - Adjacent private land
  - 4-6 ha (10-15 acres)
  - 10 initial plots for pre-commercial ventures
  - Leases with landowner
  - Heat purchased from NELH 60% below conventional prices
  - Common office/retail



DBEDT Presentation
1/7/04 (11 am panel)

Hawaii's Renewable Energy Goals

Maurice H. Kaya, P.E.

Chief Technology Officer
Department of Business, Economic Development & Tourism

January 7, 2004

www.state.hi.us/dbedt/ert

Overview

- Mandates
- Progress
- Goal

2

Mandates

- State Constitution, Article XI, Section 1:

"For the benefit of present and future generations, the State and its political subdivisions shall conserve and protect Hawaii's natural beauty and all natural resources, including land, water, air, minerals and energy sources, and shall promote the development and utilization of these resources in a manner consistent with their conservation and in furtherance of the self-sufficiency of the State. All public natural resources are held in trust by the State for the benefit of the people."

3

Mandates

- §226-18, Hawaii Revised Statutes

"Planning for the State's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all:

(1) Dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people;

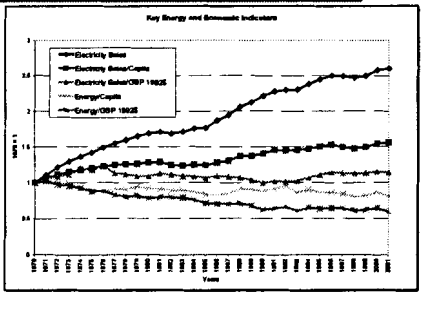
(2) Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased;

(3) Greater energy security in the face of threats to Hawaii's energy supplies and systems; and

(4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and use."

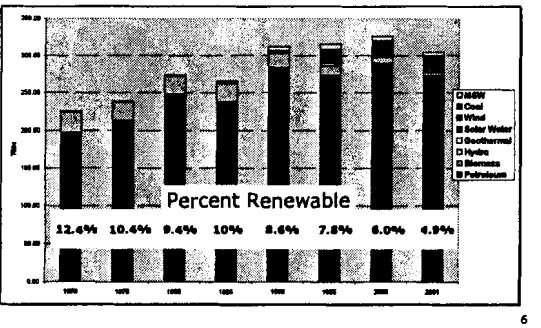
4

Progress: How Efficient Have We Become?



5

Progress: What About Renewable Energy?



6

% of Electricity Generated by Renewables by County, 2001

Fuel/Source	Hawaii	Honolulu	Kauai	Maui
Bagasse			2.3%	2.7%
Geothermal	19.7%			
Hydro	5.0%		3.9%	0.3%
LF Methane		0.1%		
MSW		3.7%		
Wind	1.7%			
Oil	67.1%	76.5%	93.8%	91.9%
Coal	6.6%	19.7%		5.1%
Total Renewable	**26.3%**	**3.8%**	**6.3%**	**3.0%**

7

Goals

"Hawaii should obtain 20 per cent of its energy from renewable energy sources by 2020."

--Governor Linda Lingle

8

The Road Ahead for Geothermal?

It would be ideal if all stakeholders who favor or oppose geothermal development could reconsider the issues, concerns, beliefs, and implications of these technologies and arrive at a consensus that is good for all of Hawaii.

9

Mahalo

DLNR Presentation
1/7/04 (11 am panel)

Geothermal Management in Hawaii
DLNR's Geothermal Program

Background (Slide 1)
The regulation of geothermal development activity is subject to four levels of land use control: 1) Geothermal Resource Subzones, 2) Geothermal Resource Mining Leases, 3) Conservation District Use Permits, and 4) County Geothermal Resource Permits. The Department of Land and Natural Resources is directly responsible for the first three of these controls.

The designation of a geothermal resource subzone is the first level of authorization relating to the siting and regulation of geothermal development activity. As part of its oversight, the Department of Land and Natural Resources has major responsibility for administration of geothermal resource subzones and management of the State's geothermal resources. The Department of Land and Natural Resources' specific responsibilities include but are not limited to regulation of all well construction and operation, issuance of geothermal resource mining leases, regulation of resource development to optimize production and prevent waste, ensuring overall public safety and protection of the environment. Under this authority, the Department of Land and Natural Resources issues permits for geothermal exploration and development, well drilling and modification of geothermal wells, well abandonment, and monitors compliance with conditions set forth in the mining lease and Plan of Operations submitted by the developer.

Geothermal Resource Subzones (Slide 2)
In 1983, the State Legislature enacted the Geothermal Resource Subzone Act authorizing the Board of Land and Natural Resources to designate geothermal resource subzones statewide. The statute provided that geothermal development activities (for electrical generation purposes) can only take place within such designated subzones. There are two areas on the Island of Hawaii and one on the Island of Maui designated as geothermal resource subzones by the Board of Land and Natural Resources. These are the Kilauea Lower East Rift Geothermal Resource Subzone (11,294 acres), the Kilauea Middle East Rift Geothermal Resource Subzone (9,014 acres) and the Haleakala Southwest Rift Geothermal Resource Subzone (4,108 acres).

The Legislature also designated three geothermal resource mining leases as geothermal resource subzones for the duration of these leases. The "grandfathered" subzone areas were: Geothermal Resource Mining Lease R-2 (816 acres) issued to Puna Geothermal Venture, Geothermal Resource Mining Lease R-3 (777 acres) issued to Barnwell Geothermal Corporation and Lease S-4602 (4 acres) issued to the Natural Energy Laboratory of Hawaii Authority. In total, 26,013 acres have been designated statewide as geothermal resource subzones.

Geothermal Resource Mining Leases (Slide 3)
Geothermal resource mining leases issued by the Board of Land and Natural Resources convey to the lessee exclusive rights to drill, discover, develop, operate,

utilize and sell geothermal resources. The lease sets forth the terms and conditions under which permitted geothermal development activities can be conducted. Six geothermal resource mining leases have been issued for a total leased area of about 14,609 acres.

A requirement of the mining lease is the submission of a Plan of Operations containing all pertinent information that the Board of Land and Natural Resources may require to evaluate the proposed utilization of geothermal resources and the preservation of the environment. The Board of Land and Natural Resources must approve the Plan of Operations prior to commencement of geothermal development activity.

Conservation District Use Permits (Slide 4)

The Board of Land and Natural Resources administers geothermal projects that lie within the State Conservation District, and the County of Hawaii administers geothermal projects located within Urban, Rural and Agricultural District lands. A Conservation District Use Permit is required for geothermal development activities on lands within the Conservation District. Generally, application for a Conservation District Use Permit requires the preparation of an environmental assessment, and if the proposed action is determined to have potentially significant environmental impacts, an environmental impact statement must be prepared. For geothermal projects permitted on conservation lands, the Department of Land and Natural Resources maintains overall regulatory responsibility for monitoring activities related to the permitted land uses, and serves as the lead agency responsible for primary regulation of geothermal power plant operations. The Department of Land and Natural Resources is also responsible for overall coordination and inter-agency communication for geothermal projects authorized on conservation lands.

Geothermal Permits (Slide 5)

The Department of Land and Natural Resources monitors and regulates operations relative to management of the geothermal resource, the design and drilling of geothermal production and injection wells, and the operation of production wells and steam gathering systems pursuant to the approved Plan of Operations for each mining lease. Department of Land and Natural Resources staff inspect operations as appropriate and are onsite during critical well drilling activity. The geothermal permits that the Department of Land and Natural Resources is responsible for are Exploration Permits, Well Drilling Permits, Well Modification Permits, Well Use Modification Permits and Well Abandonment Permits.

Closing

In addition to policy-related matters, the Department of Land and Natural Resources is the lead for onsite monitoring and serves as the State's "first line of defense" when responding to upset or emergency situations. Notwithstanding the many agencies that have some permitting oversight for geothermal development, the Department of Land and Natural Resources has overall regulatory responsibility, reviewing, evaluating and permitting both ongoing and future development activity.

Geothermal Management in Hawaii

The Department of Land and Natural Resources' Geothermal Program

Regulation of geothermal development activity is subject to 4 levels of land use control:

- Geothermal Resource Subzones
- Geothermal Resource Mining Leases
- Conservation District Use Permits
- County Geothermal Resource Permits

The Department of Land and Natural Resources is directly responsible for the first 3 of these controls.

Geothermal Resource Subzones

Kilauea Lower East Rift	11,294 acres
Kilauea Middle East Rift	9,014 acres
Haleakala Southwest Rift	4,108 acres
Lease R-2	816 acres
Lease R-3	777 acres
Lease S-4602	4 acres
TOTAL	26,013 acres

Geothermal Resource Mining Leases

- Six geothermal resource mining leases issued for a total of about 14,609 acres.
- Plan of Operations is a mining lease requirement.

A Conservation District Use Permit is required for geothermal development on lands within the State Land Use Conservation District.

Geothermal Permits

- Exploration
- Well Drilling
- Well Modification
- Well Use Modification
- Well Abandonment

DOH presentation
1/7/04 (11 am panel)

Department of Health

Clean Air Branch and
Safe Drinking Water Branch
Geothermal Monitoring Programs

January 7, 2004

Geothermal Ambient Air Monitoring

Ambient Air Quality Standard

Hawaii Administrative Rules 11-59-4 (i)
In the ambient air the average concentration of hydrogen sulfide (H_2S) measured by a reference method shall not exceed thirty-five micrograms per cubic meter of air or twenty-five parts per billion

DOH Monitoring Stations

- DOH operates three (3) ambient air monitoring stations measuring H_2S.
- Also collecting meteorological data.
- Lava Tree located near the park.
- Puna E located in Leilani subdivision
- Puna H located in Lanipuna subdivision

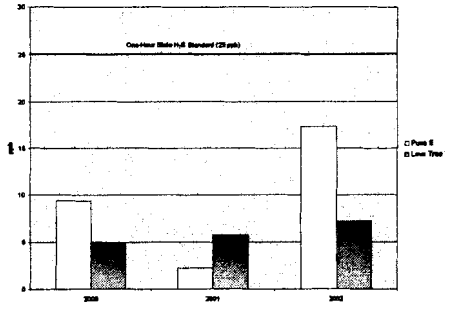
PGV Monitoring Stations

- Puna Geothermal Venture (PGV) also operates three ambient air monitoring stations down wind of their facility.
- Collecting H_2S data.
- PGV's three stations are Puna A, Puna B and Puna C.

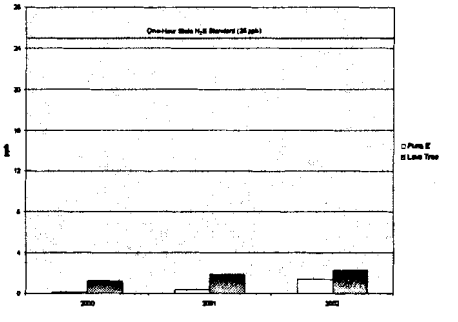
Puna H Monitoring Station

Hydrogen Sulfide Analyzers

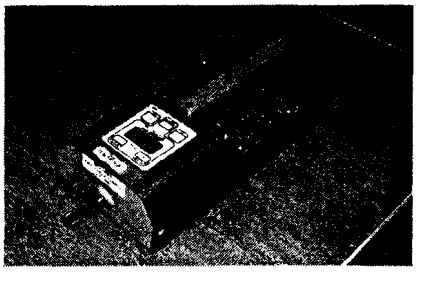
Highest 1-Hour H_2S (in ppb)



H_2S Annual Average (in ppb)



In addition to the monitoring stations DOH also uses portable Arizona Instrument Jerome (631-X) H_2S analyzers to monitor complaints and drilling activities.



Online Ambient Air Data

- The air quality data at this website is preliminary and has not been reviewed for quality assurance.
- The data is provided for information only.
- Currently only the Lava Tree and Puna E stations are online.
- www.hawaii.gov/doh/air-quality/index.html

Air Permit Program

- Hawaii Administrative Rules, Chapter 11-60.1, Air Pollution Control
- Implement all applicable state and federal air requirements including the H_2S ambient standard of 25 ppb, 1-hour average.

Air Permit

- PGV's permit regulates the air emissions from both the Power Plant and Wellfield/Drilling Operations
- Pollutants of concern are H_2S, criteria pollutants (e.g. NO_x, SO_2, particulates, carbon monoxide etc.), and Pentane.

Air Permit

- Incorporates emission limits, operational restrictions, and testing, monitoring, recordkeeping and reporting requirements
- Permits are renewed every 5 years.
- New permit is required prior to initiating any construction or modifying the facility

Underground Injection Control Program (UIC)

State Department of Health
Hawaii Administrative Rules
Chapter 11-23
Underground Injection Control

UIC Program

- Regulates the construction and operation of injection wells in Hawaii in order to protect underground sources of drinking water from injection well contamination
- An injection well is a well that is used to dispose of different types of fluids and wastewater into the subsurface

UIC Program

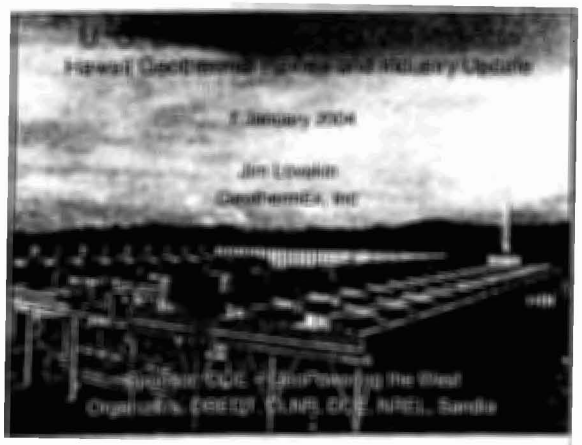
- Injection wells are typically used for disposing sewage, industrial wastewater, surface runoff, aquaculture wastewater, and geothermal fluids
- Injection wells are regulated through a UIC permit issued by the State Department of Health
- The UIC permit contains operating conditions, and monitoring and reporting requirements

UIC Program

- For geothermal operations, the UIC permit monitors for injection pressures, flow, temperature, certain chemicals used, injectant composition, injection well integrity, injection well performance, and groundwater conditions
- Monitoring and testing results are submitted periodically to the Department of Health

UIC Program

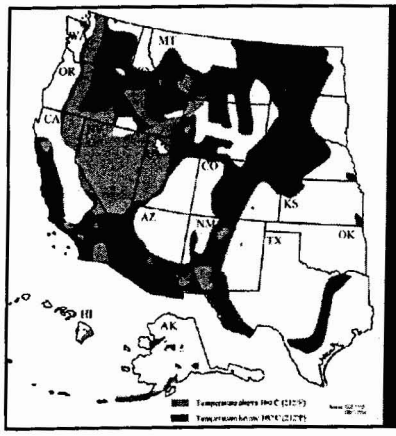
- Department of Health Inspectors periodically visit the facility to witness sample collections and field test
- A sample of the test parameters used to characterize the injectant composition is provided as a handout



Outline

1. Areas with geothermal potential
2. Existing plants
3. Expansions and new developments
4. Assessments of geothermal resources

GeothermEx, Inc. 2004



Areas with geothermal potential in western United States

GeothermEx, Inc. 2004

Geothermal Use in US

Approximately 2,150 megawatts of electricity from geothermal power plants are supplying about 3 million people in the U.S.

GeothermEx, Inc. 2004

Conversion Technologies

- Dry steam plants
- Flash plants
- Binary plants
- Hybrid (Combined Cycle) Plants

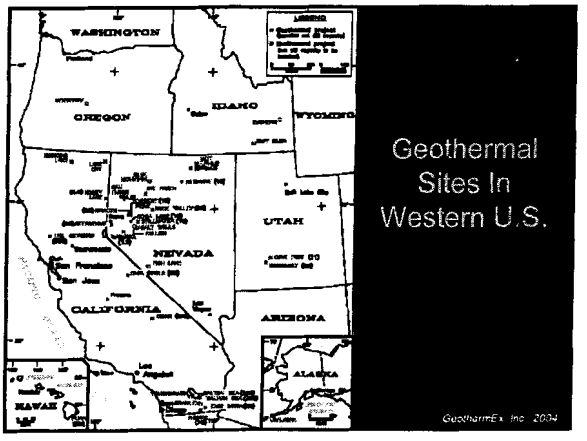
GeothermEx, Inc. 2004

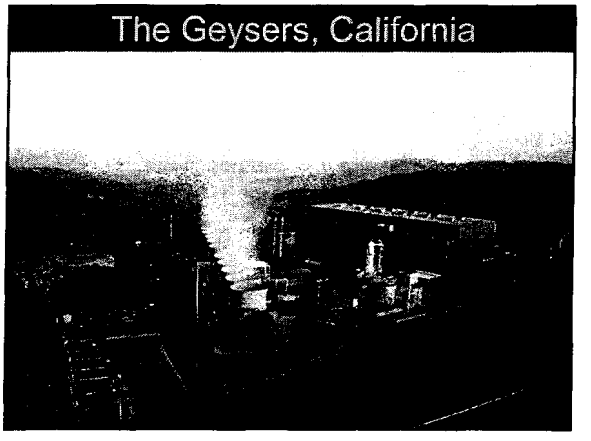
Existing Plants

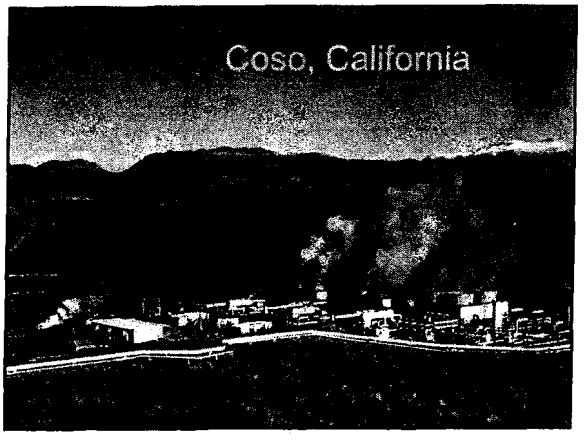
- California: 1,665 net MW from 7 fields
- Nevada: 182 net MW from 9 fields
- Utah: 31 net MW from 2 fields
- Hawaii: 30 net MW from 1 field

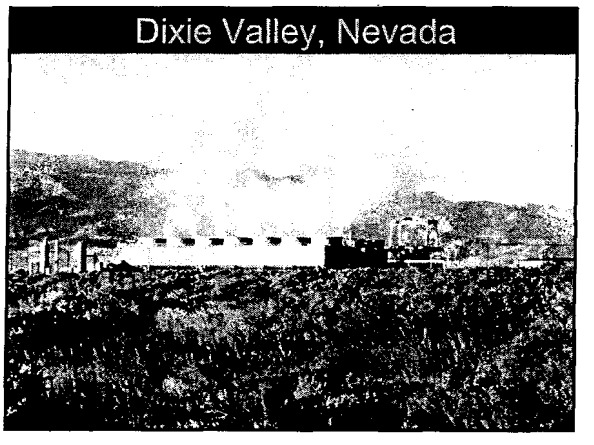
- Total: 1,908 net MW from 19 fields

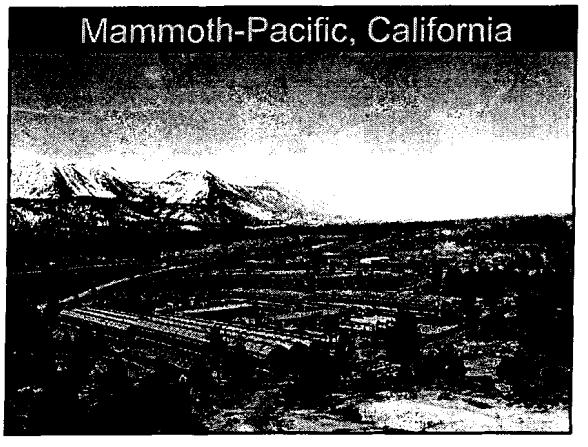
GeothermEx, Inc. 2004









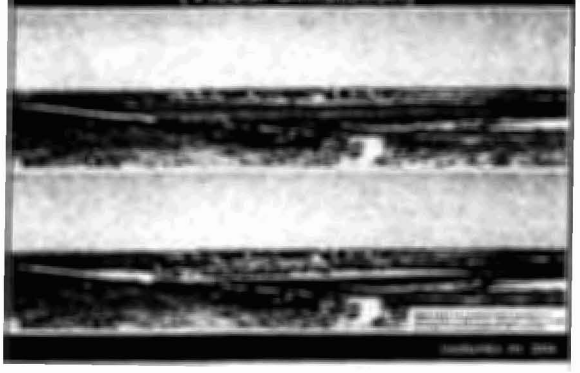


Expansions and New Developments

- Salton Sea Unit 6: 185 MW (CalEnergy)
- Medicine Lake – Fourmile Hill: 49.9 MW (Calpine)
- Medicine Lake – Telephone Flat: 48 MW (Calpine)
- Desert Peak 2 – 25 MW (Ormat)
- Desert Peak 3 – 13 MW (Ormat)
- Hot Sulphur Springs – 25 MW (Earth Power)

GeothermEx, Inc. 2004

Salton Sea Unit 6 (Visual Simulation)



Medicine Lake, California

Other Development Activity

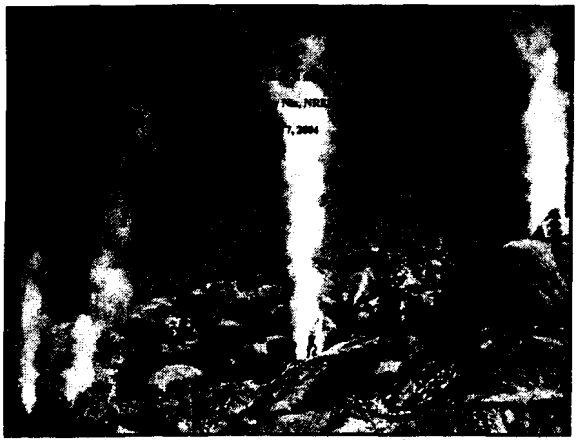
- Stillwater – northeast expansion (Leucadia)
- Lake City – temperature-gradient drilling (Natural Gas Partners)
- Raft River – testing existing wells for 10-MW project (U. S. Geothermal)
- Rye Patch – temperature-gradient drilling (Presco)
- Blue Mountain – temperature-gradient drilling (Nevada Geothermal Power)
- Fallon – US Navy seeking developer for 30-MW project
- Idaho Falls – 100 MW proposed (Idatherm)

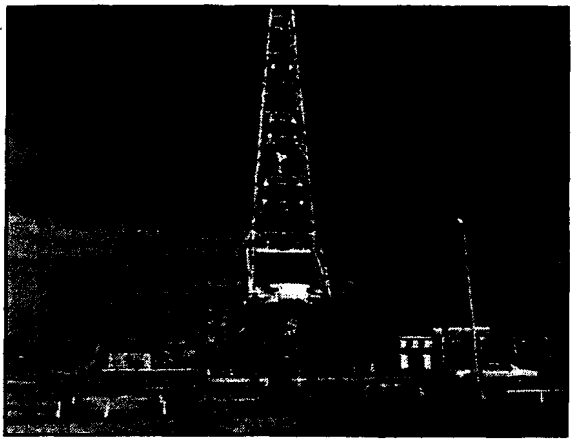
GeothermEx, Inc. 2004

Geothermal Assessments

- USGS - Circular 790 (1979)
- BLM / NREL – Opportunities for Near-Term Geothermal Development on Public Lands (February 2003)
- ITSI – Geothermal Energy Resource Assessment on Military Lands (October 2003)
- CEC / Hetch Hetchy – inventory of geothermal sites in California and Nevada (in progress)
- USGS – study of geothermal resources in the Great Basin (in progress)
- DBEDT / DLNR / GeothermEx – Assessment of Hawaii's Geothermal Resource (planned for 2004)

GeothermEx, Inc. 2004





Geothermal Technology – Similarities to oil and gas Industry except lower plant temperatures and no fuel burned


Drilling


Energy Conversion

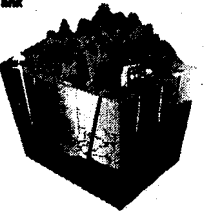

Exploration


Reservoir Technology

Geothermal Program Strategic Thrusts- 6 National Labs Involved

Drilling
- Advanced Drilling System
- High-speed data link

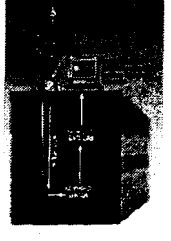
Energy Conversion
- Small modular power systems
- Improved heat rejection
- Kalina cycle demonstration



Exploration
- Integrated geophysical methods
- 3-D seismic analysis

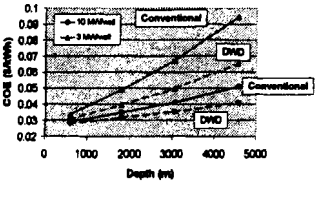
Reservoir Engineering
- Enhanced Geothermal Systems
- Tracer injection experiments

Diagnostics-while-Drilling



Revolutionize Geothermal Drilling through High-Speed Data Telemetry

- Proof-of-Concept Test - Demonstrate benefits/potential
- Field Ready System - HT hardened with rig friendly high-speed data link



What makes up DWD?

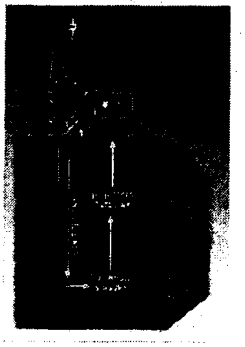
DWD Tool **– acquires and conditions data from downhole sensors**

High-Speed Data Link **- carries information and control signals between surface and downhole**

Drilling Advisory Software **- acquires, analyzes, and displays data in real time, showing drilling conditions and system performance**

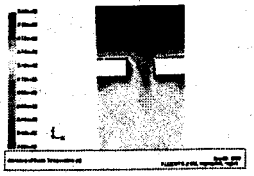
Driller **- uses traditional methods and DAS to control drilling**

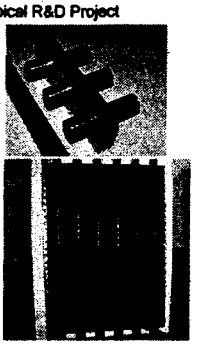
Drill Rig/Drill Pipe **- primary component for interaction between driller and the drilling process**



Air-Cooled Condenser Research – a Typical R&D Project

- Uses perforated fins
- Increases performance by 30%
- Working with manufacturer
- Computational Fluid Dynamics shows where heat transfer occurs

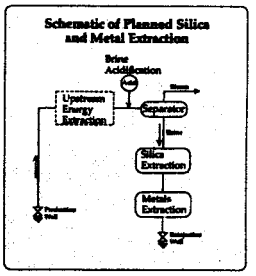




Bottom line: Can reduce cost of electricity by 0.5 cents/kWh

Silica and Metals Extraction – R&D 100 Award

- Precipitated silica is potentially a valuable by-product. Silica removal also minimizes scaling in surface facilities and during reinjection.
- Large demand currently exists for precipitated silica used as rubber additive ("green tires"), desiccant, polishing compound, paint and cement additive, odor control product, materials handling agent, and in insulation and filtration products.
- Little is currently known about how to produce silica from geothermal brines with the right properties for these applications.

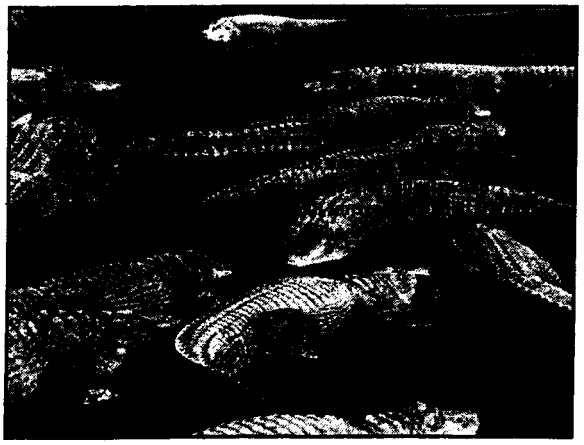


Heat Exchanger Coatings- R&D 100 Award

- NREL-BNL-industry partnerships
- Thermally conductive polymer coating (PPS composite liner) protects carbon steel tubes
- Developed through lab and field tests
- Commercialized as CurraLon®

PLANT OPTIMIZATION

- Fundamental investigation to cost-effectively improve performance
- Understand absorption-reaction mechanisms to reduce cost of pollution control chemicals
- R&D-100 award winning Advanced Direct Contact Condenser



Opportunities for Geothermal to Hydrogen in Hawaii

Hawaii Geothermal Review and Industry Update for Government Leaders and Staff

Jonathan W. Hurwitch
Senior Vice President
Sentech, Inc.

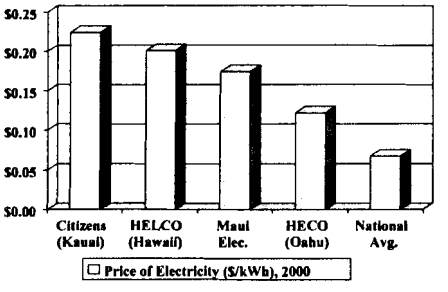
January 7, 2004

Presentation Outline

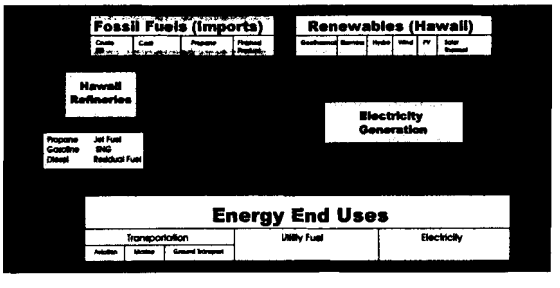
- Why Hydrogen is Important to Hawaii
- The Case for Geothermal Hydrogen
- Hawaii's Geothermal Hydrogen Opportunity

Why Hydrogen is Important to Hawaii

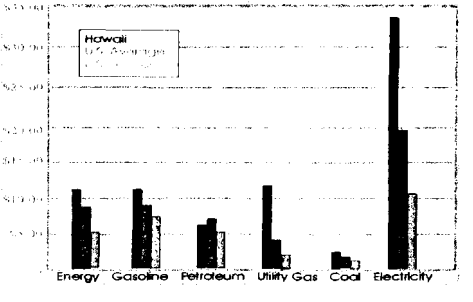
Hawaii's Electricity Prices



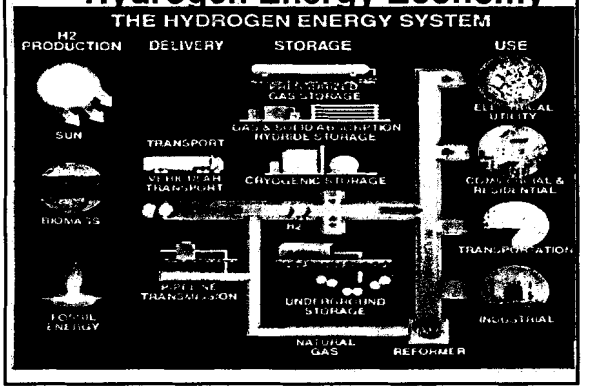
Current Hawaii Energy System



Hawaii's Energy Prices

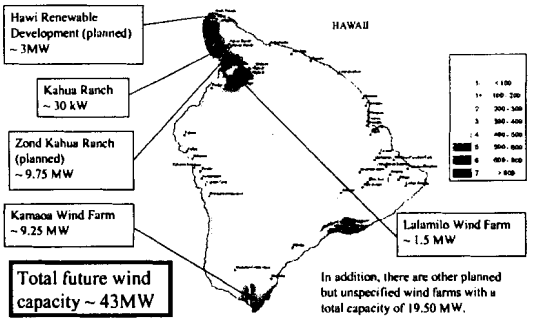


Hydrogen Energy Economy

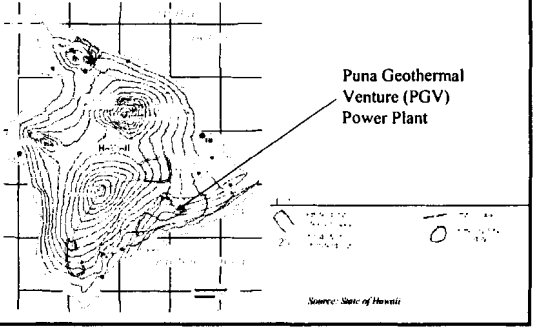


The Case for Geothermal Hydrogen

Wind Resources on Big Island



Puna Geothermal Venture Power Plant on Big Island



Geothermal-Hydrogen System Assumptions

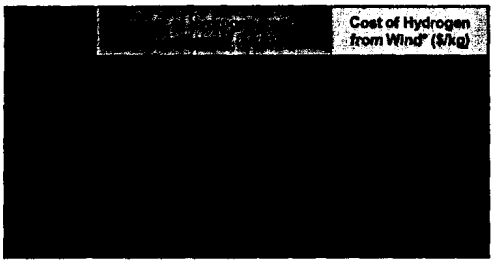
- Geothermal-Hydrogen system starts production in 2005
- Hydrogen will be produced by geothermal power only during off-peak hours, about 2,103 hours per year.
- Hydrogen will be produced at the PGV plant
- Storage is sized to store two days production of hydrogen and can be changed as needed
- Cost of feedwater for electrolyzer is negligible

Geothermal-Hydrogen System Analysis Scenario

- **Scenario**
  - PGV recovers the capital cost and O&M cost of the geothermal power plant from peak electricity sales leaving excess electricity for hydrogen product (about 2,103 operating hours per year)
  - The cost of hydrogen production is estimated based on the costs of electricity that ranges from $0.00 to $0.10/kW.

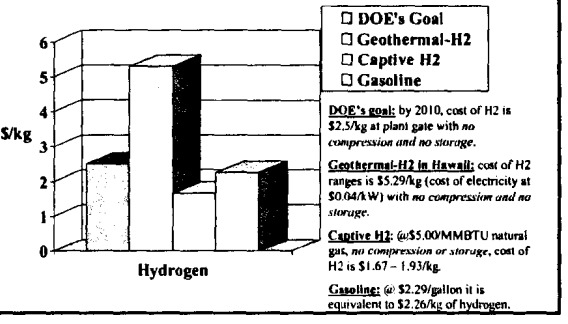
* *Assume 50% of the available hours are used to produce hydrogen.*

Preliminary Results Geothermal vs. Wind



** For Kaheawa windfarm only: with the same amount of off-peak hours ~ 2,103 hours.*

Comparison of Hydrogen Gas Price



DOE's goal: by 2010, cost of H2 is $2.5/kg at plant gate with *no compression and no storage.*

Geothermal-H2 in Hawaii: cost of H2 ranges is $5.29/kg (cost of electricity at $0.04/kW) with *no compression and no storage.*

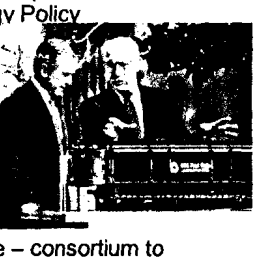
Captive H2: @$5.00/MMBTU natural gas, *no compression or storage*, cost of H2 is $1.67 – 1.93/kg.

Gasoline: @ $2.29/gallon it is equivalent to $2.26/kg of hydrogen.

Hawaii's Geothermal Hydrogen Opportunity

Fuel Cells: Center of U.S. Energy and Environmental Policy

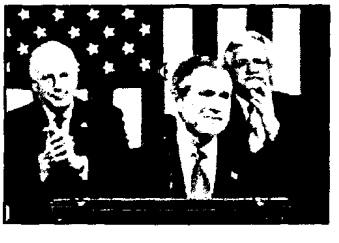
- Hydrogen is a significant part of President Bush's National Energy Policy
- Technology is major focus of U.S. Clear Skies Policy
- Fuel cell research will continue at DOE national laboratories in partnership with U.S. industry



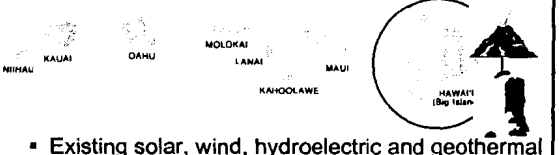
- FreedomCAR initiative – consortium to develop automotive fuel cells - $150 million for FY 2002

President's Hydrogen Fuel Initiative

January 28, 2003



Big Island Energy Picture

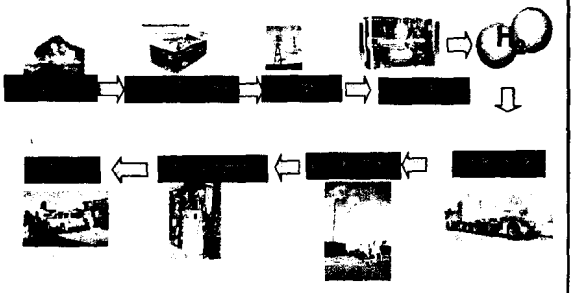


- Existing solar, wind, hydroelectric and geothermal generation
- Significant biomass and ocean resources
- 70+ MW developed or permitted

Big Island Energy Picture

- Small isolated grid (171 MW peak demand in 2000)
- High average energy cost ($0.21/kWh, $2.00 per gallon gasoline)
- Unique transmission and demand characteristics
  - Early evening peak strains transmission system
  - Lower night demand requires curtailment of renewable resources
  - Cost-effective renewable energy available off-peak for conversion into hydrogen and application in DG systems
- Major energy users have installed DER systems including solar, wind, and engine CHP systems

Integrated Hydrogen System Vision - Big Island of Hawaii



Partnerships Strengthen the Power Park at Gateway Center

Active collaboration of government, research, and industry will enable:

- **Appropriate programmatic guidance**
- **Mechanisms for sustained funding**
- **Best available technical assistance**
- **Community, government, and industry outreach**
- **Opportunities for collateral joint projects**
- **Achievement of partners' objectives**

Hawaiian Electric Company, Inc.

SunLine

Hawaii's Strengths

- DOD Assets and Political Strength
- Big Island Energy Resources and Economics (unique ability to integrate renewable hydrogen systems)
- Established relationships with DOE
- Gateway Center at NELHA
- Technology Policy QHTB Tax Credits
- Export Potential to Pacific Rim
- Hydrogen Center of Excellence at HNEI
- US – Asia Climate Change Collaboration

Summary

- Hawaii can play a leadership role for the US in developing renewable hydrogen
  - Geothermal and wind resource availability on the Big Island electrical system is unique
  - Integrated electrical and hydrogen projects under discussion
- Hydrogen may be cost-competitive transportation fuel in ten years depending upon
  - Price of gasoline
  - Cost and technology development of fuel cell cars

Energy Stakeholder Perspective: Hawaii Policy Strategies

Michael P. Hamnett
UH Social Science Research Institute

Individuals From Stakeholder Groups

- Hawaii State Senate
- Hawaii State House
- Hawaiian Electric
- Kauai Island Utility Corporation
- Solar Energy Industry
- Refineries
- The Gas Company
- County Governments
- Consumer Advocate
- Department of Health
- Honolulu Community Action Agency
- Power Light Corporation
- Hawaii Hotel Association
- Damon Estate
- Kaneohe Ranch
- Pa Ku'i A Lua
- Sierra Club
- American Institute of Architecture
- Building Industry Association
- Ahupua'a Action Alliance
- Pacific Command (US Army)
- US Senate Staff
- DBEDT
- University of Hawaii

Vision

Hawaii will have environmentally friendly, renewable, safe, reliable, and affordable energy resources. Our energy technology and systems will be efficient, with the best available emission controls; decentralized; meet consumers' needs; and maximize the use of Hawai'i's energy assets. Hawai'i will encourage investment in energy system development and continually assess energy development options based on a full accounting of costs and benefits.

Forum Efforts to Get There

- **Developed Visions Statement**
- **Identified Impediments**
- **Commissioned Studies**
- **Convened Sub-committees**
- **Held an Energy Policy Summit**
- **Now Developing a Strategy**

Commissioned Studies

- **Hydrocarbons Outlook (PDF) - Facts, Inc.**
- **Environmental requirements on energy producers (PDF) - Charles Feinstein**
- **Hawaii Energy Utility Regulation and Taxation (PDF) - Carl Freedman**
- **Social, economic and cultural issues**
- **Renewable and unconventional energy (PDF) - Warren Bollmeier**
- **Reducing Hawai'i's energy demand through increased efficiency (PDF) - Kyle Datta**

Working Groups

- Cultural Factors
- Energy Rates
- Efficiency

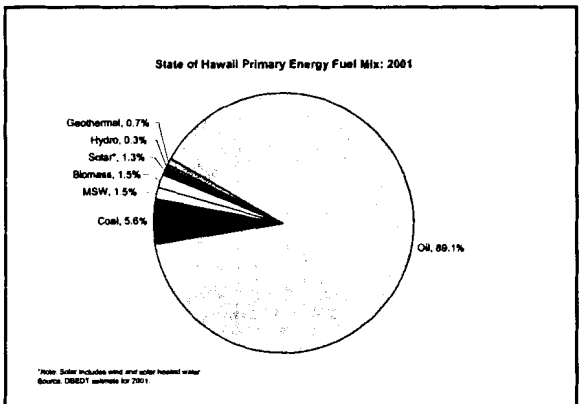
Summit

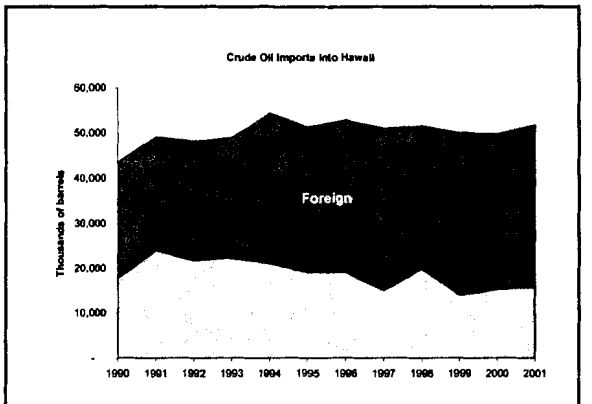
- Reviewed the Vision
- Looked at the Cost of Doing Nothing
- Examined Impediments and Opportunities
- Held Breakout Session
  - Regulatory Reform
  - Efficiency and Conservation
  - Social and Cultural Issues
  - Hydrocarbon Transition
  - Renewable Energy

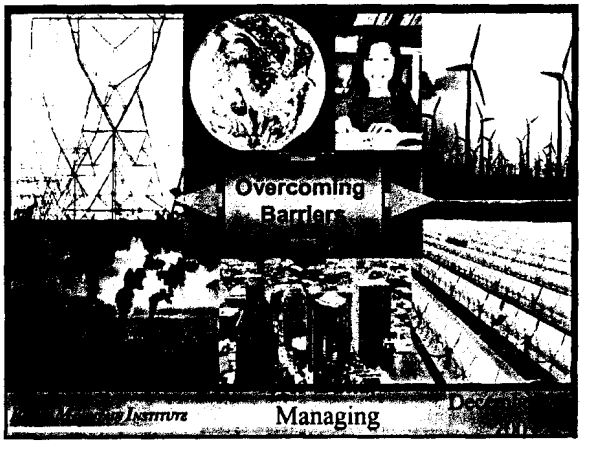
Business as Usual: Continued Dependence on Petroleum

Presented to the Hawaii Energy Policy Summit
by
Jeff Brown
December 2003

FACTS Inc







Barriers to energy efficiency and renewables

- **Utility disincentive because revenues linked with sales**
- **Access to capital**
- **Split incentives in commercial buildings between owners and tenants**
- **Asymmetric information and transaction costs**
- **Customer acquisition and marketing costs**
- **Energy not perceived as critical**

Hawaii specific implementation challenges

- Institutional capability of regulatory agencies
- Misguided rules with unintended consequences
- Island geography and multiple cultures
- Income distribution

Forum Energy Strategy

i. Regulatory Reform
ii. Energy Efficiency and Conservation
iii. Social and Cultural Issues
iv. Renewable Energy Options
v. Hydrocarbon Transition
vi. Trade Offs Across *Sectors*

Geothermal

- One of the few economically and technically viable renewable resources
- Big Island has the most promising resources and Oahu has the population
- Forum is very conscious of social and cultural issues:
  - Hawaiian Cultural Concerns
  - Social Justice

PUNA GEOTHERMAL VENTURE

HAWAII

Puna Geothermal Venture

Past:

- Exploratory drilling in '70s and '80s
- HGPA proved viability of geothermal energy generation
- Approval & opposition to geothermal development
- Learning curve with initial development, resource etc.

Present:

- Facility situated on 500 acres of designated geothermal subzone
- Location referred to as the Kilauea Lower East Rift Zone
- Current contract for 30 MW to expire in 2027
- Close regulatory monitoring of the project
- Communities: Lanipuna Gardens, Leilani Estates, Nanawale and Kapoho
- Corporate Culture: Community awareness, involvement, newsletter

Future:

- Existing land use permit will allow up to 60 MW
- UIC permits would allow additional 6 wells
- NSP would allow up to 13 additional wells
- Current spent fluids equivalent to 8–10 MW binary
- Preliminary estimate of 200–400 MW capacity in our leased area
- Keep community involved

PUNA GEOTHERMAL VENTURE

HAWAII

Puna Geothermal Venture